APPENDIX 3 TO OPINION NO 01-2025

DRAFT

Certification Specifications for Flight Simulation Training Devices (CS-FSTD)

Issue 1

Xx Month 2026[1]

Important note:
This file is published for information purposes only. No quality control has been performed yet. The draft CS-FSTD Issue 1 contained in this file is based on NPA 2024-102 consulted with the EASA Advisory Bodies through the focused consultation in 2024. The feedback and comments from that consultation have not been reflected yet in this version of the draft CS-FSTD.

[1] For the date of entry into force of Issue 1, kindly refer to ED Decision xxxxxxx in the Official Publication of EASA.

Table of contents

SUBPART A — GENERAL

CS FSTD.GEN.001 Applicability

(a) This Certification Specification (CS-FSTD) prescribes standards for the initial qualification of all aeroplane and rotorcraft Flight Simulation Training Devices (FSTDs).

GM1 CS FSTD.GEN.001 Guidance on the use of CS-FSTD

(a) The structure and suggested use of this certification specifications (CS-FSTD) are the following:

(1) Based on training needs identified in compliance with relevant regulations (e.g. Part-FCL), an applicable FSTD Capability Signature (FCS) is identified. This FCS is then used to determine the applicable FSTD related requirements, as explained below.

(i) FSTD general requirements. See Subpart B.

(ii) The necessary design data and Validation Data Roadmap (VDR). Note that CS-SIMD under OSD may be applicable. See Subpart C.

(iii) FSTD objective tests. See Subpart D.

(iv) FSTD functions and subjective tests. See Subpart E.

(v) Any other applicable requirements. See Subpart F.

(b) Requirements on the application process, testing of the FSTD and associated documentation are further described in Part-ORA.

CS FSTD.GEN.005 FSTD simulation features

(a) 'FSTD simulation feature' means a domain of simulation for which general requirements and/or testing requirements have been identified. When combined with their individual feature fidelity levels these FSTD simulation features create an FSTD Capability Signature (FCS). The fourteen FSTD simulation features can be grouped into four categories and are defined as follows.

(b) The ***Aircraft simulation*** FSTD features group comprises the following features:

(1) *Flight Deck Layout And Structure (FDK)*. Defines the level of flight deck enclosure and the physical, or perceived physical, structure, spatial representation and layout of the flight deck environment, instrument layout and presentation, controls, and pilot, instructor and observer seating.

(2) *Flight Control Forces And Hardware (CLH).* Defines the physical, flight controls appearance, travel, tactile feel and force feedback operation.

(3) *Flight Control Systems Operation (CLO).* Defines the extent of flight control system functions to be modelled in the FSTD. These include primary flight control surface displacements (e.g. surface position for aeroplanes, blade angles for rotorcraft), flight control system operation modes and logics, flight and manoeuvre envelope protection functions, flight deck indications and messages.

(4) *Aircraft Systems (SYS).* Defines the extent of aircraft systems simulation required to be modelled in the FSTD. The requirements apply where the functionalities and

indications of the aircraft systems and appropriate systems are simulated. This feature concerns the operation, interdependencies of different systems. Aircraft systems mean for example instruments, communications, navigation, autopilot, flight director, flight management, flight guidance, hydraulic, electrical, fuel, pneumatic, pressurisation, air conditioning, powerplant, auxiliary power unit, caution and warning systems, fire protection, ice and rain protection, surveillance, TAWS/GPWS/EGPWS, ACAS/TCAS, WXR, and other systems.

Note: This feature excludes the flight controls. See features 'Flight Control Forces And Hardware' and 'Flight Control Systems Operation' for their requirements.

(5) *Performance And Handling On Ground (GND).* Defines the mathematical models and associated data to be used to describe the ground handling characteristics, aerodynamic, propulsion, ground reaction and operating site surface conditions, required to be modelled in the FSTD whenever the aircraft is in contact with the surface. This includes acceleration, deceleration, turning, braking, and the effects of wind (including crosswind) where relevant to the aircraft (e.g. includes reverse thrust, the effect of the rudder).

(6) *Performance And Handling In Ground Effect (IGE).* Defines the mathematical models and associated data to be used to describe the aerodynamic, flight dynamics and propulsion characteristics required to be modelled in the FSTD close to the ground and in ground effect. The height of ground effect is the wing span, or main rotor diameter, unless otherwise declared by the OEM or data provider (as applicable).

(7) *Performance And Handling Out of Ground Effect (OGE).* Defines the mathematical models and associated data to be used to describe the aerodynamic, flight dynamics and propulsion characteristics required to be modelled in the FSTD away from the ground and out of ground effect .

(c) ***Cueing simulation*** comprising the following FSTD simulation features:

(8) *Sound Cueing (SND).* Defines the type of sound cues to be modelled and associated data. Such sound cues are those related to sounds generated externally to the flight deck environment such as sounds of aerodynamics, propulsion, rotor noises, operating site elements (e.g. runway rumble) and weather effects.

Note: Sounds generated by the aircraft systems for pilot awareness (e.g. communications systems, system and avionics audio tones, messages, cautions, warnings or any sound for indication purposes) are covered separately in the 'Aircraft Systems' feature.

(9) *Vibration Cueing (VIB)*. Defines the vibrations and buffets to be modelled in the FSTD that may be felt by the pilots during all phases of flight from such effects as airframe buffet, control surface buffet, engine and propeller or rotor and transmission vibrations, systems operation, weather, and ground operations. These vibrations may vary significantly depending on the flight parameters, for example, rotorcraft hover in or out of ground effect, hover into wind, downwind hover, hover taxi, transition to forward flight, translational lift, cruise, turns, steep turns, autorotation and so on, where relevant to the aircraft type.

Note: This feature does not contain the motion effects (e.g. touchdown cues of the landing gear). See feature 'Motion Cueing' for their requirements.

(10) *Motion Cueing (MTN).* Defines the type of motion cues that are/may be generated by the aircraft dynamics during all phases of flight. Defines the requirements on the motion cues that are generated by aircraft accelerations (due to forces on flight and ground operations) and by effects of certain events or situations.

Note: This feature does not contain the vibration and buffet cues. See feature 'Vibration Cueing' for their requirements.

(11) *Visual Cueing (VIS).* Defines the type of out-of-flight-deck window image display (e.g. collimated or non-collimated) and field of view (horizontal and vertical) that is required to be seen by the pilots using the FSTD from their reference eyepoint.

Note: This feature concerns the qualities and capabilities of the visual image. For requirements on the contents of the visual image (e.g. runway, lights, weather presentation, etc.), see features 'Operating Sites And Terrain' and 'Atmosphere And Weather'.

(d) ***Environment simulation*** comprising the following FSTD simulation features:

(12) *Navigation (NAV)*. Defines the level of simulation of the navigation aids and networks, such as ILS, VOR, DME, NDB, GNSS (e.g. GPS, SBAS, GBAS), etc. and associated instructor controls.

Note: The aircraft navigation equipment and instruments (e.g. NAV receivers, GPS units, etc.) and their databases (e.g. FMS or GPS navigation databases) are considered in the features 'Flight Deck Layout And Structure' and 'Aircraft Systems'.

(13) *Atmosphere And Weather (ATM)*. Defines the level of simulation of the simulated atmosphere and weather conditions, from ambient temperature and pressure to full thunderstorm modelling, etc.

(14) *Operating Sites And Terrain (OST)*. Defines the complexity and level of detail of the operating sites (e.g. aerodrome, landing areas) and terrain modelling required to be simulated. This includes such items as generic versus customised operating sites (such as airport, heliports, vertiports, or other landing areas), visual scenes, terrain elevation. Since some aircraft types can land at a variety of different types of landing areas, often outside aerodromes and/or controlled airspace, the environment shall include these types of landing areas in their visual scenes modelling.

CS FSTD.GEN.010 FSTD simulation feature fidelity levels

(a) 'FSTD simulation feature fidelity level' means the level of fidelity assigned to each of the defined FSTD simulation features. The fidelity levels are as follows:

(1) *Specific (S).* The highest level of fidelity for a given FSTD feature.

(2) *Representative (R).* The intermediate level of fidelity for a given FSTD feature.

(3) *Generic (G).* The lowest level of fidelity for a given FSTD feature.

(4) *None (N).* Where the fidelity level is (N), the FSTD feature is not installed, functional or available for use in training. If a feature is installed, but is not required, it shall not be distracting or detract from the other features for the intended use of the device.

(b) The requirements for the fidelity levels for each feature are given in this Certification Specification (CS-FSTD).

GM1 CS FSTD.GEN.010 Guidance on the fidelity levels

Fidelity levels (other than ‘N’) for each group of FSTD simulation features are described at a high level in Table 1 below. These summaries are broad overviews provided for guidance only. They do not encompass all aspects and are not intended to replace the requirements detailed in other subparts.

Table 1. Fidelity levels for each feature category other than None (‘N’)

Features and fidelity levels		Summary description	Validation
Aircraft simulation • FDK • CLH • CLO • SYS • GND • IGE • OGE	S	Replicates the particular aircraft type and variant appearance, tactile feel, performance and handling qualities in all phases of flight. The simulation is based on aircraft data for the particular type and variant.	Validated objectively by comparing the device against validation data for the particular aircraft type and variant.
	R	Characteristic of an aircraft type for appearance, tactile feel, performance and handling qualities in all phases of flight. The simulation is based on data for the particular aircraft type, not all necessarily for the same variant.	Validated objectively by comparing the device against validation data for the aircraft type.
	G	Appearance, tactile feel, performance and handling qualities in all phases of flight that are characteristic of an aircraft class or group. May be based on multiple data sources of different aircraft within a class or group.	Validated objectively by comparing the device against a wider variety of permissible validation data sources.
Cueing simulation • SND • VIS • MOT • VIB	S	The highest level of cueing requiring the most realistic simulation for the cueing.	Validated objectively by comparing the device cueing characteristics against flight test based validation data for the particular aircraft type and variant where applicable.
	R	The intermediate level of cueing.	Validated objectively.
	G	The lowest level of fidelity for a given FSTD feature. Simple modelling of only the essential basic cues.	Validated objectively.
Environment simulation • NAV • ATM	S	Replicates real-world environment for specified locations.	Validated subjectively.
	R	Characteristic of the real-world environment.	Validated subjectively.

• OST	G	Simple modelling of key basic environment features.	Validated subjectively.

CS FSTD.GEN.015 Terminology

(a) This CS contains the definitions and terminology used in CS-FSTD:

(1) 'Acceptable change' means a change to configuration, software, etc. which qualifies as a potential candidate for alternative approach to validation.

(2) 'Aircraft Configuration' means the setup of components like flaps and landing gear, used to adjust or optimize the aircraft's performance during different phases of flight.

(3) 'Active force feedback' means, in the context of a flight controls system, a dynamic system that produces FSTD control forces accurately reflecting those of the aircraft in all phases of flight in normal, abnormal and emergency operations.

(4) 'Additional capabilities' mean various mission equipment including but not limited to tactical equipment, air work equipment, search and rescue equipment, external loads, ship landing, etc.

(5) 'Aircraft performance data' means performance data published by the aircraft manufacturer in documents such as the aircraft flight manual (AFM), operations manual, performance engineering manual, or equivalent. The data is generally for a normalized representation of the aircraft fleet with a margin to ensure that the values represent the least performing case.

(6) 'Airspeed' means calibrated airspeed unless otherwise specified (knots).

(7) 'Airport' means a defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft. Synonymous with 'aerodrome' in this document.

(8) 'Airport clutter' means the set of ground-based entities added to a visual airport scene to create a sense of activity. Airport clutter may include both static and dynamic models such as gate infrastructure, baggage carts, ground personnel, ground service vehicles and aircraft parked or undertaking ground movements.

(9) 'Alpha/beta envelope plot' means a two-dimensional plot of FSTD envelopes with the alpha (α) axis representing the angle of attack and the beta (β) axis representing the angle of sideslip. The type of envelope being plotted varies. For example, a plot may be used to depict the 'FSTD validation envelope'.

(10) 'Alternate engines/avionics' means an FSTD which includes the simulation of an additional engine/avionics fit.

(11) 'Alternative Flight Test Data' means performance, stability and control, and other necessary test parameters, electronically or manually recorded in an aircraft using simplified and non-invasive techniques, such as flight deck video and data bus recordings, to establish a reference set of relevant parameters to which FSTD parameters can be compared.

(12) 'Alternate FSTD platform' means differing combination(s) of flight deck and platform in the context of a multi-configuration FSTD.

(13) 'Altitude' means pressure altitude (m or ft) unless specified otherwise.

(14) 'Subjective development' means the use of a documented process prior to the initial evaluation, to supplement other sources of data, to resolve issues with the available aircraft data, or to tailor the FSTD performance and handling qualities to better match the aircraft by use of judgement of qualified personnel.

(15) 'Audited engineering simulation' means an aircraft manufacturer's engineering simulation that has undergone a review by the appropriate competent authorities and been found to be an acceptable source of supplemental validation data.

(16) 'Augmented reality' means that the real world element is enhanced with a virtual overlay component using a see-through head mounted display

(17) 'Automatic testing' means using FSTD testing tools to provide the capability to set up test scenarios such that the environment, aircraft configuration, aircraft systems and control settings are exactly replicated. When auto-tests are run, the pilot control inputs are fed from the auto-test system directly into the aircraft and flight models that exactly replicate the pilot demands in magnitude and phase for the most complex sequences. This automated process ensures that exactly the same settings are used each time, removing the possibility of human error that could creep in through manual settings. The result is that a test scenario can be exactly repeated for a number of test runs for the case.

(18) 'Background radio communications' means radiotelephony messages between air traffic control and other traffic that are heard on the active frequency by the flight crew. The word 'background' refers to the fact that these messages are not intended for the ownship. Background radio communications are also known as 'party line' or 'background chatter'.

(19) 'Bank' means bank/roll angle (degrees).

(20) 'Baseline' means a fully flight-test-validated production aircraft simulation. It may represent a new aircraft type or a major derivative.

(21) 'Baseline FSTD platform' means the primary combination of flight deck and platform.

(22) 'Breakout' means the force required at the pilot's primary controls to achieve initial movement of the control position.

(23) 'Buffet' means the instability caused by turbulent stream generated by the aircraft itself (e.g. airflow separation or shock wave oscillation, or by the wake striking another part of the airframe).

(24) 'Class of aircraft' means aircraft having similar operating characteristics and operated with the privileges of a pilot class rating.

(25) 'Closed loop testing' means an objective testing method in which the test input stimuli are adjusted by closed-loop controllers or drivers (also known as 'math-pilot') to follow a predefined target response.

(26) 'Computer controlled aircraft (CCA)' means an aircraft where the pilot inputs to the control surfaces are transferred and augmented via computers.

(27) 'Control sweep' means a movement of the appropriate pilot's control from neutral to an extreme limit in one direction (forward, aft, right, or left), a continuous movement

back through neutral to the opposite extreme position, and then a return to the neutral position.

(28) 'Convertible FSTD' means an FSTD in which hardware and software can be changed so that the FSTD represents a different aircraft type, variant, class or group. The same FSTD platform, flight deck shell, motion system, visual system, computers, and necessary peripheral equipment can thus be used in more than one simulation.

(29) 'Correct trend and magnitude (CT&M)' means a method of comparing FSTD objective test results against validation data without the use of numerical tolerances by using sound engineering judgement.

(30) 'Critical engine parameter' means the primary parameter(s) that is used to set the engine power/thrust in the aircraft.

(31) 'Damping (critical)' means that minimum damping of a second order system such that no overshoot occurs in reaching a steady state value after being displaced from a position of equilibrium and released. This corresponds to a relative damping ratio of 1:0.

(32) 'Damping (over-damped)' means the damping of a second order system such that it has more damping than is required for critical damping, as described above. This corresponds to a relative damping ratio of more than 1:0.

(33) 'Damping (under-damped)' means the damping of a second order system such that a displacement from the equilibrium position and free release results in one or more overshoots or oscillations before reaching a steady state value. This corresponds to a relative damping ratio of less than 1:0.

(34) 'Daylight visual' means a visual system capable of meeting, as a minimum, system brightness, contrast ratio requirements and performance criteria appropriate for the level of qualification or FCS sought.

(35) 'Deadband' means the amount of movement of the input for a system for which there is no reaction in the output or state of the system observed.

(36) 'Design Data' means aircraft manufacturer or equipment OEM data used as part of the aircraft design and certification process. Design Data may be used for simulation modelling purposes and to help substantiate the Reference Data established by the VDR or ER.

(37) 'Driven' means a state where the objective test input stimulus or variable is 'driven' or deposited by automatic means, generally a computer input. Typical methods are the use of open loop and closed-loop drivers.

(38) 'Engineering judgement' means making a determination on a problem or test result using accepted engineering principles and all available relevant information.

(39) 'Engineering Report (ER)' means a document produced by the FSTD manufacturer to substantiate the Design Data and Validation Data used to develop and verify the FSTD. For objective tests making use of CT&M tolerances or where a toleranced comparison against the Reference Data is not possible, the ER should substantiate the FSTD test results via written justification or other means.

(40) 'Engineering simulation' means an integrated set of mathematical models representing a particular aircraft configuration, which is typically used by the aircraft manufacturer for a wide range of engineering analysis tasks including engineering

design, development and certification. It is also used to generate data for checkout, proof-of-match/validation and other training FSTD data documents.

(41) 'Engineering simulator' means the aircraft manufacturer's or data provider's simulator, which typically includes a full-scale representation of the simulated aircraft flight deck, operates in real time and can be flown by a pilot to subjectively evaluate the simulation. It contains the engineering simulation models for FSTDs, which are also released by the aircraft manufacturer to the industry. The engineering simulator may or may not include actual on-board system hardware in lieu of software models.

(42) 'Engineering simulator data' means data generated by an engineering simulation or engineering simulator, depending on the aircraft manufacturer's processes.

(43) 'Engineering simulator validation data' means validation data generated by an engineering simulation or engineering simulator.

(44) 'Entity' means, in the context of the simulated environment, an aircraft, ground vehicle, or other dynamic object.

(45) 'Entry into service' means the original state of the configuration and systems at the time a new or major derivative aircraft is first placed into commercial operation.

(46) 'Equipment and specifications list' (ESL) means a list which is part of the FSTD qualification and provides accurate and comprehensive information regarding the device qualification and basis, installed equipment, capabilities and specifications.

(47) 'Essential match' means a comparison of two sets of objective test results for which the differences should be negligible.

(48) 'Extended reality' (XR) is an encompassing term to refer to Virtual Reality, VR; Mixed Reality, MR; and Augmented Reality, AR.

(49) 'Field of view' of an XR headset is defined as the extent of the observable display of the headset at a static position. It is typically measured in degrees and describes the angular extent of the display, both horizontally and vertically, from the perspective of the HMD's wearer. The observable FOV depends on the geometry of the human skull, most dominantly of the eye relief distance (distance from the rear lens to the eye).

(50) 'Field of regard' of an XR headset is defined as the range of vision of an XR headset. It is typically measured in degrees and describes the angular range of the display, both horizontally and vertically, from the perspective of the headset's wearer – including when moving the wearer's head around a central reference point.

(51) 'Flight deck' means the shell of the cockpit and all associated panels, seats, controls, etc. 'Aft of the flight deck' refers to the area behind the pilots' seats or rear bulkhead that normally contains instructor and observer seating and other non-aircraft-related features.

(52) 'Flight test data' means actual aircraft data obtained by the aircraft manufacturer (or other supplier of acceptable data) during an aircraft flight test programme.

(53) 'Footprint Data' means the test results recorded as a result of subjective development and approved during the initial evaluation.

(54) 'Footprint test' means test results recorded and approved on the FSTD during its initial evaluation, to be used as the basis for establishing an Essential Match during recurrent evaluations of the FSTD. In the event of an approved change to the FSTD affecting

objective test results, the competent authority may require that the test result be re-generated under the new conditions to form new Footprint Data. For feature fidelity levels R and G, Footprint Data may comprise a portion of the Reference Data for subsequent FSTDs.

(55) 'Free response' means the hands-off response of the aircraft after completion of a control input or disturbance.

(56) 'Frozen/locked' means a state where a variable is held constant with time.

(57) 'FSTD capability signature (FCS)' means the information that is endorsed on an FSTD qualification certificate, indicating the features and related fidelity levels as well as the simulated aircraft of an FSTD in accordance with CS-FSTD;

(58) 'FSTD Configuration' means that set of components and software necessary to ensure the device has the capability to provide the necessary training, testing, or checking capability for the FCS being sought.

(59) 'FSTD data' means the various types of data used by the FSTD manufacturer and the applicant to design, manufacture, test and maintain the FSTD.

(60) 'FSTD evaluation' means a detailed appraisal of an FSTD by the competent authority to ascertain whether or not the standard required for a specified qualification level or FCS is met.

(61) 'FSTD operator' means that organisation directly responsible to the competent authority for requesting and maintaining the qualification of an FSTD.

(62) 'FSTD qualification' means the process of evaluating a FSTD to determine its FCS.

(63) 'FSTD qualification baseline data' means the set of agreed tests and data for use during recurrent evaluations.

(64) 'Flight simulation training device (FSTD)' means a device for pilot training, testing and checking whose qualification certificate includes an FSTD capability signature (FCS) or, in case of a legacy FSTD,

(i) for aeroplanes, is a full flight simulator (FFS), a flight training device (FTD), a flight and navigation procedures trainer (FNPT) or a basic instrument training device (BITD); or

(ii) for helicopters, is a full flight simulator (FFS), a flight training device (FTD) or a flight and navigation procedures trainer (FNPT).

(65) 'FSTD training envelope' means high and moderate confidence regions of the FSTD validation envelope.

(66) 'FSTD user' means the organisation or person requesting training, checking or testing through the use of an FSTD.

(67) 'FSTD validation envelope' means an alpha/beta envelope (or equivalent method) depicting the 'confidence level' of the aerodynamic model. The envelope is defined by three regions, Flight-test-validated, Wind tunnel or analytical, and Extrapolated (See CS FSTD.QB.125 (b)(ii) for further definition).

(68) 'Fuel used' means the quantity of fuel consumed as recorded in the aircraft simulation. This can be represented in various units, such as kilograms, pounds, litres, gallons, percentage of total, or any other valid format that provides relevant data to the pilot

(69) 'Full stall' or 'Post-stall regime' means flight conditions at an angle of attack greater than the critical angle of attack.

(70) 'Full sweep' means the movement of the controller from neutral to a stop, usually the aft or right stop, to the opposite stop and then to the neutral position.

(71) 'Functional performance' means an operation or performance that can be verified by objective data or other suitable reference material that may not necessarily be flight test data.

(72) 'Functions test' means a quantitative or qualitative assessment of the operation and performance of an FSTD by a suitably qualified evaluator. The test can include verification of correct operation of controls, instruments, and systems of the simulated aircraft under normal and non-normal conditions.

(73) 'General requirements' means the requirements given in CS FSTD.QB.101, CS FSTD.QB.102, CS FSTD.QB.103, CS FSTD.QB.104, CS FSTD.QB.105, CS FSTD.QB.106, CS FSTD.QB.107, CS FSTD.QB.108, CS FSTD.QB.109, CS FSTD.QB.110, CS FSTD.QB.111, CS FSTD.QB.112, CS FSTD.QB.113, CS FSTD.QB.114 and CS FSTD.QB.115.

(74) 'Ground effect' means the change in aerodynamic characteristics due to modification of the airflow around the aircraft caused by the presence of the ground at heights the length of the aeroplane's wingspan or rotor diameter of a rotorcraft above the ground or water, unless otherwise declared by the OEM or data provider (as applicable).

(75) 'Ground reaction' means forces acting on the aircraft due to contact with the ground. These forces include the effects of strut deflections, tyre friction, side forces, structural contact and other appropriate aspects. These forces change appropriately, for example, with weight and speed.

(76) 'Group of aircraft' means aircraft that have similar handling and operational characteristics.

(77) 'Hands-off manoeuvre' means a test manoeuvre conducted or completed without pilot control inputs.

(78) 'Hands-on manoeuvre' means a test manoeuvre conducted or completed with pilot control inputs as required.

(79) 'Heavy' means with operational mass at or near maximum for the specified flight condition.

(80) 'Height' means the height above ground/AGL (m or ft).

(81) '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.

(82) 'Highlight brightness' means the maximum displayed brightness that satisfies the appropriate visual cueing feature objective brightness test.

(83) 'Icing accountability' means a demonstration of minimum required performance whilst operating in the maximum and intermittent maximum icing conditions of the applicable airworthiness requirement. It refers to changes from normal (as applicable to the individual aircraft design) in take-off, climb (en-route, approach, landing) or landing operating procedures or performance data, in accordance with the AFM, for flight in icing conditions or with ice accumulation on unprotected surfaces.

(84) 'Initial evaluation' means the first assessment to determine whether an FSTD performs to the standard of the relevant qualification basis;

(85) 'Intended use' means the training, testing and checking tasks that the device is built to be able to support;

(86) 'Integrated testing' means testing of the FSTD such that all aircraft system models are active and contribute appropriately to the results. None of the aircraft system models should be substituted with models or other algorithms intended for testing only. This may be accomplished by using controller displacements as the input. These controllers should represent the displacement of the pilot's controls and these controls should have been calibrated.

(87) 'Interpupillary distance' is the measurement of the distance between the centres of the pupils of the eyes when the observer focuses at an object with a certain distance. It is required to ensure proper alignment and fit of an XR headset to ensure optimal visual comfort and performance of the virtual display. Industry standards typically define it as the distance between the centres of the pupils when looking straight ahead, measured in millimetres. IPD may be measured as a single value with two distances from the centre to each eye.

(88) 'Irreversible control system' means a control system in which movement of the control surface will not backdrive the pilot's control on the flight deck.

(89) 'Latency' means the additional time, beyond that of the basic perceivable response time of the aircraft due to the response time of the FSTD.

(90) 'Light' means with operational mass at or near minimum for the specified flight condition.

(91) 'Line-oriented flight training (LOFT)' refers to flight crew training which involves full-mission simulation of situations which are representative of line operations, with special emphasis on situations which involve communications, management and leadership. It means 'real-time', full-mission training.

(92) 'Manual testing' means FSTD testing where the pilot conducts the test without computer inputs except for initial set-up. All modules of the simulation should be active.

(93) 'Master qualification test guide (MQTG)' means the QTG to be used as the reference for future testing and evaluations. The MQTG approval and amendments processes are presented in Part-ORA and Part-ARA.

(94) 'Medium' means the normal operational weight for the flight segment.

(95) 'Mixed reality' means that real environment (including camera perceived) elements and computer-generated elements are merged. Physical and virtual content are presented to the observer on a head mounted display. All elements may co-exist in MR and interact in real-time. (For example the image from a head mounted camera system is presented within a virtual environment, VE).

(96) 'Modification' means a change to an FSTD;

(97) 'Near performance-limited condition' means, when related to approach to stall or stall, a stall event occurring close to the lowest limit of the following:

(i) maximum certified altitude (structural) or maximum operating envelope;

(ii) thrust-limited altitude; and

(iii) buffet- or manoeuvre-limited altitude.

(98) 'Night visual' means a visual system capable of meeting, as a minimum, the visual cueing feature system brightness and contrast ratio requirements and performance criteria appropriate for the level of qualification sought. The system, when used in training, should provide, as a minimum, all features applicable to the twilight scene, as defined below, with the exception of the need to portray reduced ambient intensity that removes ground cues that are not self-illuminating or illuminated by ownship lights (e.g. landing lights).

(99) 'Nominal' means the normal operational weight, configuration, speed, etc. for the flight segment specified.

(100) 'Non-normal control' means, in reference to computer-controlled aircraft, the state where one or more of the intended control, augmentation or protection functions are not fully available. Note: Terms such as ALTERNATE, DIRECT, SECONDARY, BACKUP, etc., may be used to define the actual level of degradation for different aircraft types.

(101) 'Normal control' means, in reference to computer-controlled aircraft, the state where the intended control, augmentation and protection functions are fully available.

(102) 'Objective test (objective testing)' means a quantitative assessment based on comparison with data.

(103) 'Off-axis' means the axis (X, Y, Z, pitch, roll, yaw) other than the primary axis for an objective test. For example, helicopters typically have cross-couplings leading to a flight control input resulting in an output on the controlled axis (primary axis) but also on another perpendicular axis (off-axis).

(104) 'One step' means the degree of changes to an aircraft that would be allowed as an acceptable change, relative to a fully flight-test-validated simulation. The intention of the alternative approach is that changes would be limited to one, rather than a series, of steps away from the baseline configuration. It is understood, however, that those changes that support the primary change (e.g. weight, thrust rating and control system gain changes accompanying a body length change) are considered part of the 'one step'.

(105) 'Open-loop testing' means an objective testing method in which the test input or variable is driven or directly replayed. Small explainable offsets/biases are acceptable, closed loop followers are not acceptable.

(106) 'Operating Site' means aerodrome, airport, heliport, vertiports, or other landing areas, visual scenes.

(107) 'Other Data' means non-aircraft data used for validation data that are typically approved for use with feature fidelity levels R and G. Other Data may include Design Data, Aircraft Performance Data, Footprint Data, Aircraft Certification Specifications, and other sources (see Subpart C for further information).

(108) 'Other flight controls' mean flight controls that are not classified as primary flight controls. These include but are not limited to for example trims, flaps lever, speed brake lever, landing gear lever.

(109) 'Other traffic' means entities other than the ownship in the simulated environment. This traffic will include other aircraft, both airborne and on the ground, and may also include ground vehicles as part of an airport scene.

(110) 'Ownship' means the virtual representation of the user-controlled aircraft within a flight simulation environment.

(111) 'Platform' means, for example:

(i) motion system; or

(ii) visual system; or

(iii) computers; or

(iv) necessary additional equipment; or

(v) any combination of the above that can be used in more than one configuration.

(112) 'Phase of flight' means' in the case of aeroplanes taxiing, the take-off run, the take-off flight path including climb, cruise, descent, approach, the final approach, the missed approach, the landing, including the landing roll, and any other phases of flight as required. In the case of rotorcraft it means taxiing, hovering, take-off, final approach, missed approach, the landing and any other phases of flight as required.

(113) 'Pitch trim' refers to the pitch trim tab, horizontal stabiliser, canard, etc. as applicable to the simulated aircraft.

(114) 'Power lever angle' means the angle of the pilot's primary engine control lever(s) on the flight deck. This may also be referred to as PLA, throttle, or power lever.

(115) 'Predicted data' means data derived from sources other than flight tests for the particular aircraft.

(116) 'Primary axis' means the axis (X, Y, Z, pitch, roll, yaw) under scrutiny during an objective test. For example, the primary axis for a power change dynamics test is the pitch axis.

(117) 'Primary flight control' means the controls that are required for immediate control of the aircraft. For a typical aeroplane, typically identified as column, wheel, pedal, engine/thrust control levers (e.g. throttles, propeller levers, etc.), tiller and toe brakes. For a typical helicopter, identified as cyclic, collective and pedals.

(118) 'Primary reference document' (PRD) means the technical specification or set of technical specifications used to establish the qualification basis for FSTD.

(119) 'Proof-of-match (POM)' means a document that shows agreement within defined tolerances between model responses and flight test cases at identical test and atmospheric conditions.

(120) 'Protection functions' means systems functions designed to protect an aircraft from exceeding its flight and manoeuvre limitations.

(121) 'Pulse input' means an abrupt input to a control followed by an immediate return to the initial position.

(122) 'Qualification test guide (QTG)' means a document established to demonstrate that the FSTD complies with the prescribed tolerances and applicable requirements of the primary reference document(s) for the simulated aircraft type, class or group.

(123) 'Recurrent evaluation' means the periodic assessment subsequent to the initial evaluation to establish whether an FSTD continues to perform to the standard of the relevant qualification basis; 'Reversible control system' means a partially powered or unpowered control system in which movement of the control surface will backdrive the pilot's control on the flight deck or affect its feel characteristics.

(124) 'Robotic test' means a basic performance check of a system's hardware and software components. Exact test conditions are defined to allow for repeatability. The components are tested in their normal operational configuration and may be tested independently of other system components.

(125) 'Simulated ATC environment' means the simulation of other traffic entities within an airspace or ground environment, along with the associated ATC radio and data communications to other traffic and the ownship within this wider context.

(126) 'Simulated Aircraft' means the simulated aircraft type and variant and/or aircraft class or group used for qualification of the FSTD.

(127) 'Statement of justification (SOJ)' means documentation giving justification and information on how each requirement is met or why it is considered not to be applicable.

(128) 'Snapshot' means a presentation of one or more variables at a given instant of time.

(129) 'Special evaluation' means any assessment of an FSTD other than the initial and recurrent evaluations;

(130) 'Step input' means an abrupt input held at a constant value.

(131) 'Subjective test (subjective testing)' means a qualitative assessment based on established standards as interpreted by a suitably qualified person.

(132) 'Test condition' means either flight phase, aircraft configuration, flight conditions, environmental conditions, flight manoeuvres or weight/cg conditions as required for applicable objective validation tests in the table of validation tests.

(133) 'Throttle lever angle (TLA)' means the angle of the pilot's primary engine control lever(s) on the flight deck.

(134) 'Time history' means a presentation of the change of a variable with respect to time.

(135) 'Tolerance' in the context of objective tests refers to the maximum acceptable deviation from the validation data. The tolerances may be either numerical or assessment of CT&M.

(136) 'Transport delay' means the total FSTD system processing time required for an input signal from a pilot primary flight control until the motion system, visual system, or instrument response. It is the overall time delay incurred from signal input until output response. It does not include the characteristic delay of the aircraft simulated.

(137) 'Twilight (dusk/dawn) visual' means a visual system capable of meeting, as a minimum, the system brightness and contrast ratio requirements and performance criteria appropriate for the level of qualification sought. The system, when used in training, should provide, as a minimum, full-colour presentations of reduced ambient

intensity (as compared with a daylight visual system), sufficient to conduct a visual approach, landing and airport movement (taxi).

(138) 'Type of aircraft' means a categorisation of aircraft requiring a type rating as determined in the operational suitability data established in accordance with Annex I (Part-21) to Regulation (EU) No 748/2012 (OSD), and which includes all aircraft of the same basic design including all modifications thereto except those which result in a change in handling or flight characteristics.

(139) 'Update' means the improvement or enhancement of an FSTD.

(140) 'Upgrade' means the improvement or enhancement of an FSTD for the purpose of achieving a different FCS.

(141) 'Upset' means an undesired aeroplane state characterised by unintentional deviations from parameters experienced during normal operations. An aeroplane upset may involve pitch or bank angle deviations as well as inappropriate airspeeds for the given conditions.

(142) 'Validation' means the process to assess the capabilities of an FSTD for training, testing and checking.

(143) 'Validation Data (VD)' means the Validation Source Data subset that is to be used as Reference Data during the initial evaluation.

(144) 'Validation Data Roadmap (VDR)' means a document that clearly identifies (in matrix format) the source(s) of data for all the FSTD's required objective tests together with the applicable rationales or explanations. It should also provide validity with respect to engine type and thrust rating and the revision levels of all avionics that affect aircraft handling qualities and performance. For further information, refer to CS FSTD.ENG.015 Validation Data Roadmap.

(145) 'Validation flight test data' means performance, stability and control, and other necessary test parameters, electrically or electronically recorded in an aircraft using a calibrated data acquisition system of sufficient resolution and verified as accurate to establish a reference set of relevant parameters to which FSTD parameters can be compared.

(146) 'Validation Source Data (VSD)' means aircraft reference data that is composed of ground and flight test data, as well as engineering data and other sources, which is used to objectively confirm that the FSTD reflects the static as well as the dynamic handling and performance characteristics of the aircraft and its relevant systems.

(147) 'Variant of aircraft' means an aircraft model/name within different aircraft that are operated with a pilot type rating (e.g. A320-100 and A321-200 are different variants of A320). An aircraft type or model may have only one variant (e.g. A380 aircraft type has only one variant A380-800).

(148) 'Verification' means the process to ensure that an FSTD meets the applicable technical qualification requirements.

(149) 'Vibration' means periodic or random motion effects or movement created by the aircraft or other environmental effects.

(150) 'Virtual reality' means that the environment is either partially or completely represented virtually on a head mounted display (HMD).

(151) 'Visual ground segment test' means a test designed to assess items impacting the accuracy of the visual scene presented to the pilot at a decision height (DH) on an instrument landing system (ILS) approach.

(152) 'Visual system response time' means the interval from an abrupt control input to the completion of the visual display scan of the first video field containing the resulting different information.

(153) 'Well-understood effect' means an incremental change to a configuration or system that can be accurately modelled using proven predictive methods based on known characteristics of the change.

CS FSTD.GEN.020 Abbreviations

This CS contains the abbreviations used in CS-FSTD:

A	=	aeroplane
A/C	=	aircraft
ACAS	=	airborne collision avoidance system
Ad	=	total initial displacement of pilot controller (initial displacement to final resting amplitude)
ADF	=	automatic direction finder
ADS-B	=	automatic dependent surveillance — broadcast
ADS-C	=	automatic dependent surveillance — contract
ADS-R	=	automatic dependant surveillance — rebroadcast
AFM	=	aircraft flight manual
AFCS	=	automatic flight control system
AGL	=	above ground level (m or ft)
A_n	=	sequential amplitude of overshoot after initial x-axis crossing, e.g. A_1 means the 1st overshoot.
AEO	=	all engines operating
AIRAC	=	aeronautical information regulation and control
AOA	=	angle of attack (degrees)
AOC	=	aeronautical operational communications
APCH	=	approach i.a.w PBN navigation specification
APSD	=	acceleration power spectral density
APU	=	auxiliary power unit
APV	=	approach procedures with vertical guidance
AR	=	augmented reality
ATC	=	air traffic control
ATIS	=	automatic terminal information service
ATO	=	approved training organisation
ATM	=	Atmosphere And Weather feature
Baro	=	barometric
BC	=	ILS localiser back course
CAT I	=	category I operations with decision height not lower than of 200 ft and RVR in accordance with the operational weather minima

CAT II	=	category II operations with decision height below 200 ft and down to 100 ft and RVR in accordance with the operational weather minima
CAT III	=	category III operations with decision height below 100 ft or no decision height and RVR in accordance with the operational weather minima
CCA	=	computer-controlled aircraft
cd/m2	=	candela per square meter, 3.4263 candela/m^2 = 1 ft-Lambert
CDFA	=	continuous descent final approach
CFIT	=	controlled flight into terrain
CLH	=	Flight Control Forces And Hardware feature
CLO	=	Flight Control Systems Operation feature
CoG	=	centre of gravity
CPDLC	=	controller pilot data link communications
cm(s)	=	centimetre, centimetres
CS	=	Certification Specifications
CT&M	=	correct trend and magnitude
D-ATIS	=	data link ATIS
daN	=	decaNewtons (1 daN = 10 N)
dB	=	decibel
deg	=	degree (°)
DGPS	=	differential global positioning system
DH	=	decision height
DLIC	=	data link initiation capability
DME	=	distance measuring equipment
DOF	=	degrees of freedom
DPBL	=	defined point before landing
EFB	=	electronic flight bag
EFVS	=	enhanced flight vision system
EGPWS	=	enhanced ground proximity warning system
EM	=	essential match
EPR	=	engine pressure ratio
EVS	=	enhanced vision system
EW	=	empty weight
FAA	=	Federal Aviation Administration
FADEC	=	full authority digital engine control

FANS	=	Future Air Navigation System
FATO	=	final approach and take-off area
FCS	=	FSTD capability signature
FD	=	flight director
FDK	=	Flight Deck Layout And Structure feature
FMS	=	flight management system
FOR	=	field of regard
FOV	=	field of view
FPM	=	feet per minute
ft	=	feet, 1 foot = 0.304801 meters
ft-Lambert	=	foot-Lambert, 1 ft-Lambert = 3.4263 candela per square meters
F&S	=	functions and subjective testing
g	=	acceleration due to gravity (m/s^2 or ft/s^2), 1g = 9.81 m/s^2 or 32.2 ft/s^2
G	=	Generic (as related to fidelity level)
$grms^2$	=	mathematical expression for g's root mean squared
G/S	=	glideslope
GBAS	=	ground-based augmentation system
GND	=	Performance And Handling On Ground feature
GNSS	=	global navigation satellite system
GPS	=	global positioning system
GPWS	=	ground proximity warning system
H	=	helicopter/rotorcraft
HGS	=	head-up guidance system
HMD	=	head mounted display
HSI	=	Horizontal situation indicator
HTAWS	=	Helicopter Terrain Awareness and Warning System
HUD	=	head-up display
HUGS	=	head-up guidance system
Hz	=	unit of frequency, 1 Hz = one cycle per second
IAS	=	indicated airspeed
IATA	=	International Air Transport Association
ICAO	=	International Civil Aviation Organization
IGB	=	inlet gearbox

IGE	=	in ground effect
IGE	=	Performance And Handling In Ground Effect feature
ILS	=	instrument landing system
IMC	=	instrument meteorological conditions
in	=	inches, 1 in = 2.54 cm
Init	=	initial objective test (i.a.w. tolerances)
IOS	=	instructor operating station
IPD	=	interpupillary distance
IR	=	infrared
JAA	=	Joint Aviation Authorities
JAWS	=	Joint Airport Weather Studies
JOEB	=	Joint Operations Evaluation Board (JAA)
km	=	kilometers, 1 km = 0.62137 statute miles
kPa	=	kiloPascal (kilo Newton per one square meter). 1 psi = 6.89476 kPa
kt	=	knots, calibrated airspeed unless otherwise specified, 1 knot = 0.5148 m/s or 1.689 ft/s
lb	=	pounds
lbf	=	pound-force, 1 lbf = 4.448 2 newton
LDP	=	landing decision point
LED	=	light emitting diode
LNAV	=	lateral navigation
LOC	=	localiser
LOC-BC	=	localiser back course
LOFT	=	line-oriented flight training
LOS	=	line-oriented simulation
LP	=	localiser performance
LPV	=	localiser performance with vertical guidance
LRU	=	line replaceable unit
LSAP	=	loadable software aircraft part
m	=	meters, 1 meter = 3.28083 ft
MCC	=	multi-crew cooperation
MCTM	=	maximum certified take-off mass (kilos/pounds)
MDA	=	minimum descent altitude
MGB	=	main gearbox

min	=	minutes
MLG	=	main landing gear
MLS	=	microwave landing system
mm	=	millimeters
Mmo	=	maximum operating limit speed (Mach)
MPa	=	megaPascals (1 psi = 6894.76 pascals)
MQTG	=	master qualification test guide
MR	=	mixed reality
ms	=	millisecond(s)
MTN	=	Motion Cueing feature
MTOW	=	maximum take-off weight
n	=	sequential period of a full cycle of oscillation
N	=	None (as related to fidelity level), or, Normal control state referring to computer-controlled aircraft (depending on context)
N/A	=	not applicable
NAV	=	Navigation feature
NDB	=	non-directional beacon
NM	=	nautical mile, 1 nautical mile = 6 080 ft = 1 852 m
NN	=	non-normal control, a state referring to computer-controlled aircraft
NR	=	main rotor speed
NVIS	=	night vision imaging systems
Nx	=	load factor in the aircraft x-axis direction
Ny	=	load factor in the aircraft y-axis direction
Nz	=	load factor in the aircraft z-axis direction
NWA	=	nosewheel angle (degrees)
N1	=	engine low pressure rotor revolutions per minute expressed in percent
N1/Ng	=	gas generator speed
N2	=	engine high pressure rotor revolutions per minute expressed in percent
N2/Nf	=	free turbine speed
OEB	=	Operations Evaluation Board
OEI	=	one engine inoperative
OEM	=	original equipment manufacturer
OFS	=	obstacle free sector
OGE	=	out-of-ground effect

OGE	=	Performance And Handling Out Of Ground Effect feature
O/G	=	on ground
OST	=	Operating Sites And Terrain feature
P0	=	time from pilot controller release until initial x-axis crossing (x-axis defined by the resting amplitude)
P1	=	first full cycle of oscillation after the initial x-axis crossing
P2	=	second full cycle of oscillation after the initial x-axis crossing
PANS	=	procedure for air navigation services
PAPI	=	precision approach path indicator system
PAR	=	precision approach radar
PBN	=	performance-based navigation
Pf	=	impact or feel pressure
PLA	=	power lever angle
PLF	=	power for level flight
Pn	=	sequential period of oscillation
POM	=	proof-of-match
PSD	=	power spectral density
psi	=	pounds per square inch. (1 psi = 6.89476 kPa)
QC	=	qualification certificate
QFE	=	altimeter pressure setting related to a particular reference datum point (e.g. aerodrome elevation)
QNH	=	altimeter pressure setting related to sea level
OSD	=	operational suitability data as in Annex I (Part 21) to Commission Regulation (EU) No 748/2012
PBN	=	performance based navigation
QTG	=	qualification test guide
QTG(A)	=	qualification test guide for aeroplane FSTD
QTG(H)	=	qualification test guide for rotorcraft FSTD
R	=	Representative (as related to fidelity level)
R/C	=	rate of climb (m/s or ft/min)
R/D	=	rate of descent (m/s or ft/min)
Rad	=	radian
RAE	=	Royal Aerospace Establishment
RAeS	=	Royal Aeronautical Society

RAT	=	ram air turbine
Rec	=	recurrent objective test (i.a.w. tolerances)
REIL	=	runway end identifier lights
RFM	=	rotorcraft flight manual
RMS	=	root mean square
RNAV	=	area navigation
RNP	=	required navigation performance
RNP AR	=	approach in accordance with the RNP AR navigation specification, where AR stands for ‘authorization required’
RPM	=	revolutions per minute
RTO	=	rejected take-off
RVR	=	runway visual range (m or ft)
s	=	second(s)
S	=	Specific (as related to fidelity level)
SBAS	=	satellite-based augmentation system
SELCAL	=	selective-calling radio system
sec(s)	=	second, seconds
sm	=	statute mile, 1 statute mile = 5 280 ft = 1 609 m
SME	=	subject matter expert
SND	=	Sound Cueing feature
SOJ	=	statement of justification
SPL	=	sound pressure level
SYS	=	Aircraft Systems feature
T(A)	=	tolerance applied to amplitude
T(Ad)	=	tolerance applied to residual amplitude
T(p)	=	tolerance applied to period
T/O	=	take-off
TACAN	=	tactical air navigation
TASE	=	training areas of specific emphasis associated with the OSD reports
TAWS	=	terrain awareness warning system
TCAS	=	traffic alert and collision avoidance system
TDM	=	training device manufacturer
TDP	=	take-off decision point
Tf	=	total time of the flare manoeuvre duration

Ti	=	total time from initial throttle movement until a 10% response of a critical engine parameter
TIS-B	=	traffic information service — broadcast
TLA	=	throttle lever angle
TLOF	=	touchdown and lift-off
TR	=	tail-rotor
TRGB	=	tail-rotor gearbox
Tt	=	total time from Ti to a 90% increase or decrease in the power level specified
UPRT	=	upset prevention and recovery training
VASI	=	visual approach slope indicator system
VDR	=	validation data roadmap
VE	=	virtual environment
VFR	=	visual flight rules
VHF	=	very-high frequency
VGS	=	visual ground segment
VIB	=	Vibration Cueing feature
VIS	=	Visual Cueing feature
VMC	=	visual meteorological conditions
Vmca	=	minimum control speed (air)
Vmcg	=	minimum control speed (ground)
Vmcl	=	minimum control speed (landing)
Vmu	=	minimum unstick speed
VMO	=	maximum operating limit speed (airspeed)
VNAV	=	vertical navigation
VOR	=	VHF omni-directional range
VR	=	virtual reality
Vr	=	rotate speed
Vs	=	stall speed or minimum speed in the stall
V_1	=	critical decision speed
VTOSS	=	take-off safety speed (also referenced as V2)
Vy	=	optimum climbing speed / best rate of climb airspeed
Vw	=	wind velocity
WAT	=	weight, altitude, temperature

X	=	The axis pointing through the nose of the aircraft
XR	=	extended reality
Y	=	The axis pointing to the right of the X-axis (facing in the pilot's direction of view), perpendicular to the x-axis
Z	=	The axis pointing down through the bottom of the craft, perpendicular to the x-y plane in accordance with the right hand rule
1st segment	=	the portion of the take-off profile from lift-off to completion of gear retraction
2nd segment	=	the portion of the take-off profile from after gear retraction to end of climb at V2 and initial flap/slat retraction
3rd segment	=	the portion of the take-off profile after flap/slat retraction is complete

SUBPART B — QUALIFICATION BASIS

GENERAL

CS FSTD.QB.001 Qualification standards

(a) Any FSTD submitted for initial evaluation shall be evaluated against applicable CS-FSTD criteria for the requested FCS.

(b) The FSTD shall be subjected to:

(1) objective tests; and

(2) functions and subjective tests.

(c) The qualification test guide (QTG), including all data, supporting material and information shall be submitted in a format to allow efficient review and evaluation before the FSTD can gain qualification and an FCS. Where applicable, the QTG shall be based on the aircraft validation data as defined by the operational suitability data (OSD) established in accordance with Annex I (Part 21) to Commission Regulation (EU) No 748/2012.

CS FSTD.QB.005 Minimum FCS

(a) In order to use this CS-FSTD as the qualification basis for any FSTD, the FCS shall have at least the features and fidelity levels presented in Table 1 below.

Table 1. Minimum FCS

<table>
<tr><th>Feature</th><th>Fidelity level</th></tr>
<tr><td>Flight Deck Layout And Structure</td><td>G</td></tr>
<tr><td>Flight Control Forces And Hardware</td><td>N</td></tr>
<tr><td>Flight Control Systems Operation</td><td>G</td></tr>
<tr><td>Aircraft Systems</td><td>G (see note 1)</td></tr>
<tr><td>Performance And Handling On Ground</td><td rowspan="3">G (see note 2)</td></tr>
<tr><td>Performance And Handling In Ground Effect</td></tr>
<tr><td>Performance And Handling Out Of Ground Effect</td></tr>
<tr><td>Sound Cueing</td><td>N</td></tr>
<tr><td>Vibration Cueing</td><td>N</td></tr>
<tr><td>Motion Cueing</td><td>N</td></tr>
<tr><td>Visual Cueing</td><td>N</td></tr>
<tr><td>Navigation</td><td>N</td></tr>
<tr><td>Atmosphere And Weather</td><td>G</td></tr>
<tr><td>Operating Sites And Terrain</td><td>N</td></tr>
</table>

Note 1: At least one aircraft system shall be simulated.

Note 2: At least one Performance And Handling feature shall be at G or a higher fidelity level.

GM1 CS FSTD.QB.005 Minimum FCS

(a) While some features may be at fidelity level N, it is fundamental that a select number of the features are at level G, R or S to qualify any FSTD in accordance with this CS that potentially enables the FSTD to be used for accredited training. Rationales for the minimum FCS selection can be summarised as follows:

(1) Flight Deck Layout And Structure - It is fundamental that an FSTD can enable at least some interface with the user.

(2) Flight Control Forces And Hardware - Some aircraft systems training tasks can be performed with no tactile flight controls hardware, so this feature could be at fidelity level N. For example a 2D flat panel trainer.

(3) Flight Control Systems Operation - This feature is fundamental as flight control systems are fundamental, even for automatic flight systems management training, and they interface with multiple aircraft systems.

(4) Aircraft Systems - It is fundamental to have some aircraft system (e.g. basic instruments) simulated.

(5) Performance And Handling On Ground - If the intended training is limited to flying in and/or out of ground effect only, and not ground operations, this feature could be at fidelity level N.

(6) Performance And Handling In Ground Effect - If the intended training is limited to flying out of ground effect, this feature could be at fidelity level N.

(7) Performance And Handling Out Of Ground Effect - This feature is fundamental for any flight training tasks. It is not the intention to use CS-FSTD as the qualification basis for FSTDs that are solely ground based.

(8) Sound Cueing - This feature could be at level N. Not all training tasks require sound cueing.

(9) Vibration Cueing - This feature could be at level N. Not all training tasks require vibration cueing.

(10) Motion Cueing - This feature could be at level N. Not all training tasks require motion cueing. For example fixed base FSTDs.

(11) Visual Cueing - This feature could be at level N. Not all training tasks require a visual system or visual cueing.

(12) Navigation - This feature could be at level N if the training tasks are limited to visual navigation under VFR.

(13) Atmosphere And Weather - This feature is fundamental for any flight training tasks. The performance and handling models rely upon even basic atmospheric parameter simulation.

(14) Operating Sites And Terrain - This feature could be at level N. Not all training tasks require a visual system or visual cueing.

CS FSTD.QB.010 Requirements for an FCS

(a) An FSTD comprises a set of features, each with a defined fidelity level. The levels of fidelity can be either N, G, R or S. The FSTD Capability Signature (FCS) for an FSTD details the features and associated fidelity level of each feature. The features are defined in CS.FSTD.GEN.005 and the levels are defined in CS FSTD.GEN.010.

(b) This CS gives criteria for fidelity levels G, R and S for each feature. To gain a certain level for a certain feature, all the requirements in this CS-FSTD applicable to that level shall be fulfilled. As an exception, the individual aircraft systems may be at different fidelity levels which again affects the Aircraft Systems feature in the FCS. The documentation of the FSTD shall clearly define the fidelity level of each applicable aircraft system.

(c) If the feature or aircraft system is not simulated, the feature is at fidelity level N. If the feature or aircraft system does not comply with all the requirements for any of the levels G, R or S, the feature or system is considered to be at level N.

(d) The FCS, together with the defined fidelity of each simulated aircraft system, define the applicable objective tests and functions and subjective tests that are required for the qualification of the FSTD.

(e) The FSTD shall have an FCS and the fidelity of each simulated aircraft system that support the intended use of the device and enable integration, validation and verification of the device.

(f) The features, and the aircraft systems shall operate and correspond appropriately and seamlessly in an integrated manner and appropriate sequence.

GM1 CS FSTD.QB.010 Requirements for an FCS

(a) The training requirements define what FCS is required for training tasks. The features and fidelity levels in the FCS enable a wide range of possibilities so a wide variety of FSTDs may be qualified. For example, an FSTD may not have any flight controls hardware on the flight deck, but the flight control operation (e.g. system logic, indications, warning, etc.) may be at the highest level.

(b) To gain a certain level for any feature, all the applicable requirements (e.g. general requirements in Subpart B, engineering and data requirements in Subpart C, objective test requirements in Subpart D and functions and subjective test requirements in Subpart E) should be fulfilled. For example, even if the feature otherwise fulfils the general requirements for level S, but the used data fulfils only level R requirements, the feature can be qualified only to level R.

(c) The Aircraft Systems may have individual systems modelled at different fidelity levels. For example, the flight management and auto-flight systems of an FSTD may be at Specific fidelity level, while the pressurisation system is only at Representative level. The aircraft systems cannot always be treated in isolation since they often integrate with other systems. This may result in having to alter some of the aircraft systems in order to have a proper integration of aircraft systems in the FSTD. As an example, the flight management system (FMS) and flight director (FD) systems may be integrated in the real aircraft and consequently the integration of these in the FSTD may not be achieved if one of them is at the Generic fidelity level while the other one is at the Specific level.

(d) Individual features and their fidelity levels cannot be treated in isolation. The training device will be used in an integrated manner and certain features may have a dependency upon other features for integrated operation. The features and systems should operate and correspond appropriately, meaning that for example a TCAS traffic shown on the flight deck display should appear correspondingly in the visual system, if a visual is fitted.

(e) This may result in the planned FCS having to be altered to ensure compliance and correspondence among all the features. Examples on this:

(1) It may not be possible to have the Performance And Handling features at Specific level if the Flight Control Forces And Hardware is at Generic level because some objective tests (e.g. 2.a.8) may not demonstrate compliance with the requirements. It may be necessary to enhance the Flight Control Forces And Hardware feature above level G.

(2) It may not be possible to have the Performance And Handling features at Specific level if the Flight Control Systems Operation is at Generic level. This is because the Flight Control Systems Operation gives inputs to the flight dynamics model. In addition, the autoflight control system contributes to the inputs. To be able to demonstrate compliance, it may be necessary to enhance the Flight Control Systems Operation feature above level G.

(3) Specific level for the Vibration Cueing feature cannot be gained if the Performance And Handling features have low fidelity levels because the vibration system receives its inputs from the flight model. If the inputs (e.g. triggering of stall buffet for aeroplane, or translational lift for helicopter) are not given at correct conditions, the resulting vibration/buffet cues may not fulfil the requirements for the Specific level.

(4) An EGPWS is considered as an aircraft system, but if a visual system is installed, the visual image should seamlessly support the EGPWS indications (e.g. mountains, obstacles). The lowest level of Operating Sites And Terrain feature may not support this and consequently the level of that feature may have to be enhanced.

CS FSTD.QB.015 FSTD general requirements for feature fidelity levels

(a) The CS FSTD.QB.101 through CS FSTD.QB.114 provide the general requirements for each FSTD feature and fidelity levels for aeroplanes and rotorcraft. Certain aircraft types (e.g. tilt rotor aircraft) have characteristics of both aeroplanes and rotorcraft. For such aircraft, the applicable general requirements may be a combination of both aeroplane and rotorcraft requirements and/or Special Conditions.

(b) The miscellaneous requirements applicable to all FSTDs, but not related to any feature fidelity level, are given in CS FSTD.QB.115.

(c) For the aircraft simulation FSTD features group (see CS FSTD.GEN.005), on the Specific fidelity level, the FSTD shall simulate a certain aircraft type and variant. On the Representative fidelity level, the FSTD shall simulate a certain aircraft type. On the Generic fidelity level, the FSTD shall be characteristic of an aircraft class or group and the FSTD’s performance and handling and system simulation shall comply with the certification requirements of real aircraft for that class or group.

(d) For each FSTD feature, the general requirements are split into individual requirements with unique numbers. Tick marks indicate which fidelity levels (G, R, S) the requirements are applicable to. The organisation requesting qualification of an FSTD with a given FCS shall select, for each FSTD feature, all the individual requirements applicable to the fidelity level of this FSTD feature. All of these requirements are applicable to the FSTD.

(e) Objective tests shall support the demonstration of compliance with the general requirements and consequently establish a baseline for recurrent evaluations. In the tables of general requirements, the columns ‘QTG’, ‘QTG(A)’ and ‘QTG(H)’ contain, where applicable, the reference to the section of objective tests, or a reference to a certain objective test. The applicable individual objective tests and requirements are determined in accordance with Subpart D. These objective tests shall be included in the MQTG.

(f) Functions and subjective testing is a process requiring pilot expertise to assess the FSTD. In the tables of general requirements, the column ‘F&S’ contains tick marks to indicate when compliance with the requirement shall be ensured and demonstrated by functions and subjective testing. Details of functions and subjective test requirements can be found in Subpart E. Many tests are for certain piloting tasks or manoeuvres, such as take-off. Such tests are associated with more than one feature and therefore require integrated testing, simultaneously checking all the features and cues in the simulation. The functions and subjective testing criteria are dictated by the general requirements applicable to the FCS.

GM1 CS FSTD.QB.015(d) Objective tests

(a) The QTG references in the tables of general requirements enable traceability between requirements and verification and validation. The cross-references to the objective test sections ensure a minimum level of traceability for the general requirements.

(b) The columns for objective testing in the general requirements tables are defined as:

(1) ‘QTG(A)’ columns refer to the objective tests for aeroplanes.

(2) ‘QTG(H)’ columns refer to the objective tests for rotorcraft.

(3) ‘QTG’ columns are used for the features where the tests are not assigned to aeroplanes or rotorcraft separately.

(c) Examples of objective test reference notations:

(1) ‘1.a’ is a reference to the objective test section 1.a.

(2) ‘2.c.8.b’ is a reference to the individual objective test 2.c.8.b.

(3) ‘3.e, 3.f’ is a reference to two objective test sections 3.e and 3.f.

(4) ‘1.e-1.h’ is a reference to all the objective test sections from 1.e to 1.h.

CS FSTD.QB.017 Additional capabilities

(a) An FSTD may have additional aircraft systems and/or capabilities for which this CS-FSTD does not specify requirements. To verify and validate the suitability of those, the organisation requesting qualification of an FSTD shall:

(1) Declare and justify the impact of the additional capabilities on all the features;

(2) Give a proposal to the competent authority on how to validate (i.e. through objective testing and/or functions and subjective testing) the additional capabilities;

(3) Verify that the aircraft systems and capabilities operate as described in the appropriate reference (e.g. aircraft flight manual or its supplement);

(4) Validate and verify that the additional capabilities are suitable for the training use; and

(5) Include the applicable information in the MQTG.

GM1 CS FSTD.QB.017 Additional capabilities

(a) The words ‘additional capabilities’ mean various mission equipment including but not limited to tactical equipment, air work equipment, search and rescue equipment, external loads, ship landing, etc.

Note: Requirements for certain systems (e.g. HUD and EFVS) are given in the section ‘Miscellaneous’ as entities rather than having their requirements split between different features.

(b) The purpose is to assess and evaluate the additional aircraft systems and/or capabilities in a systematic way to ensure positive transfer of training.

(c) Any additional aircraft system and/or capability may affect many of the aircraft features. For example, any external equipment such as load on a helicopter hoist, will affect the Performance And Handling features because the load affects weight, drag, moments, dynamics, crash limits, and so on. The Flight Deck Layout And Structure would be affected if there are any additional panels or pilot interfaces. The visual image contents would be affected if the load should be visible in the visual image. Similarly for any other affected feature.

CS FSTD.QB.020 Statements of Justification

(a) All the general requirements included in CS FSTD.QB.101 through CS FSTD.QB.115 shall be presented by the organisation requesting qualification of an FSTD in Statements of Justification (SOJ). The Statements of Justification shall:

(1) Follow the numbering of the tables in CS FSTD.QB.101 through CS FSTD.QB.115.

(2) List all the general requirements (including their numbers) in CS FSTD.QB.101 through CS FSTD.QB.115 that are applicable to the FCS of the FSTD.

(3) Give justification on how each requirement is met or why it is considered not to be applicable to the FSTD in question. The given justification shall be clear and sufficiently detailed to give evidence and information on how the requirement is fulfilled.

The Statements of Justification shall refer to the sources of information and show the compliance rationale to explain how compliance is reached, how the referenced material is used, applicable mathematical equations and parameter values, and conclusions reached.

For requirements which are not applicable to the simulated aircraft, state 'Not Applicable' and provide an explanation if warranted.

(4) Be part of the MQTG and/or Engineering Report.

(5) Be dated and signed by the organisation requesting qualification of the FSTD.

(6) Be revised in case of modifications to the device.

GM1 FSTD.QB.020 Statements of Justification

The Statements Of Justification (SOJ) should be clear and sufficiently detailed to give evidence and information on how the requirement is fulfilled. The scope of information should be appropriate for the requirement on FSTD in question. For example, an SOJ regarding a complex topic (e.g. a stall event, aircraft stability, icing, etc.) is necessary longer than an SOJ for a simple and straightforward topic (e.g. visual field of view). Complex topics have more aspects to consider in the SOJ.

The examples below demonstrate the difference in scope of information for some imaginary cases. The examples are given in a table format which is the recommended format for the SOJs.

Table 1 provides an example of the SOJ for a feature that uses an OEM data package. The SOJ is simple and straightforward because it is expected that the OEM has all the necessary information to create a detailed data package that supports accurate replication of the aircraft. If the FSTD uses a different data source (e.g., reverse engineering), the SOJ must include much more detailed information to demonstrate how the requirements are met.

Table 2 provides an example of the SOJ for a feature at the Generic fidelity level. For any SOJ at the Generic level, it is important to provide clear information on what is being simulated and how it is being done.

Table 3 provides an example of the SOJ for a case where the general requirement clearly is not applicable to the simulated aircraft.

Table 1. Example of SOJ for an FSTD simulating an Airbus A320 (computer controlled aircraft) and having the feature 'Flight Control Systems Operation' at Specific fidelity level

Number	Requirement	Statement Of Justification
3.4.1	The flight control systems functions for flight and manoeuvre envelope protection functionality shall replicate the simulated aircraft type and variant.	The simulation is based on the OEM data package, VDR and validation data. The flight control system operation replicates all aspects of the Airbus sEFCS V06.00.00, including the flight and manoeuvre envelope protection functionalities. The objective tests in MQTG test section 2.h demonstrate that these functionalities accurately replicate the aircraft. Additionally, functional and subjective testing confirm that the functionalities perform correctly under various conditions and configurations.

Table 2. Example of SOJ for an FSTD simulating a single-engine turbine aeroplane and having the feature 'Atmosphere And Weather' at Generic fidelity level

Number	Requirement	Statement Of Justification
13.2.1	The standard atmosphere shall be simulated, and the	The mathematical model in the FSTD for the standard atmosphere adheres to the International Standard Atmosphere (ISA) as

	instructor shall have control over key parameters.	published by the International Organization for Standardization (ISO) in ISO 2533:1975. The model includes the linear distribution of pressure, temperature, density, and viscosity as functions of altitude from 2,000 feet below mean sea level up to the tropopause (11 kilometres). The simulated aircraft does not have sufficient performance to climb above the tropopause, so the simulation of the atmosphere above this level is not applicable to the device. The atmospheric variables are calculated using formulas via floating point calculations, ensuring there are no discontinuities. The instructor has controls to affect the following atmospheric parameters: - QNH (1 hPa resolution) - Temperature at mean sea level - Temperature lapse rate In addition, the instructor has controls for the following weather settings: - Wind speed and direction at various altitudes - Wind gusts - Turbulence level - Cloud layers

Table 3. Example of SOJ for an FSTD simulating an Airbus A320 and having the feature 'Performance and Handling Out Of Ground Effect' at Representative fidelity level

Number	Requirement	Statement Of Justification
7.1.6	For rotorcraft: The performance and handling characteristics in hover in OGE and through translational lift and transition to forward flight shall be characteristic of the simulated aircraft type.	This requirement is not applicable to this simulated aircraft. The requirement is for rotorcraft, while the simulated aircraft is an aeroplane.

CS FSTD.QB.030 Qualification test guide (QTG)

(a) Qualification test guide (QTG) means a document established to demonstrate that the FSTD complies with the prescribed tolerances and applicable requirements of the primary reference document(s) for the simulated aircraft type, class or group. The QTG resulting from the initial evaluation process becomes the Master qualification test guide (MQTG; see Part-ORA and Part-ARA). The MQTG may be later revised as applicable (e.g. due to modifications).

(b) The QTG delivered to the competent authority for the purpose of becoming the first MQTG shall contain all the test results, Statements of Justification and other information to demonstrate that the FSTD meets the requirements and test criteria. It shall include the following:

(1) A title page.

(2) Means to show evidence of the approval of the MQTG and its revisions.

(3) An FSTD information page (for each configuration in the case of convertible FSTDs) providing:

(i) FSTD identification number used by the organisation requesting qualification of the FSTD;

(ii) Simulated aircraft for each feature (i.e. class or group, type, or type and variant) in the aircraft simulation FSTD features group (see CS FSTD.GEN.005);

(iii) General description of each feature;

(iv) references to aerodynamic design data or sources for aerodynamic model;

(v) references to engine design data or sources for engine model;

(vi) references to flight control design data or sources for flight controls model (which shall include a declaration of simulated primary flight control system - e.g. CCA aircraft, reversible or irreversible flight control system);

(vii) avionic equipment system identification and references to simulated avionics source data, include a listing of avionics systems which are simulated, how these systems are simulated, and which OEM documents (Pilot Guide, FCOM, AFM, etc.) can be used as the reference to the system;

(viii) FSTD model and manufacturer;

(ix) Month of FSTD manufacture;

(x) FSTD computer identification;

(xi) visual system type and manufacturer (if fitted); and

(xii) motion system type and manufacturer (if fitted);

(4) Table of contents.

(5) List of effective pages

(6) Revision history.

(7) List of objective tests (including run date and test revision).

(8) Glossary of terms, acronyms and symbols used.

(9) Statements of Justification (SOJ).

(10) Validation Data Roadmap (VDR).

(11) Engineering Report (ER).

(12) Recording procedures and required equipment for the objective tests.

(13) All the applicable objective tests and results.

(14) All the applicable functions and subjective tests and results.

FLIGHT DECK LAYOUT AND STRUCTURE (FDK)

CS FSTD.QB.101 FSTD general requirements for Flight Deck Layout and Structure (FDK)

1: FLIGHT DECK LAYOUT AND STRUCTURE
Defines the level of flight deck enclosure and the physical, or perceived physical, structure, spatial representation and layout of the flight deck environment, instrument layout and presentation, panels and switches, interaction with the flight deck components, and pilot, instructor, and observer seating. Note: This feature excludes the flight controls. See feature 'Flight Control Forces And Hardware' in CS FSTD.QB.102 for their requirements. Note: This feature does not contain the aircraft system operation and functionalities (e.g. logics of the systems). See feature 'Aircraft Systems' in CS FSTD.QB.104 for their requirements.

The general requirements for the Flight Deck Layout And Structure feature are presented in the table below.

1: FLIGHT DECK LAYOUT AND STRUCTURE							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
1.1	ENCLOSURE REQUIREMENTS						

1: FLIGHT DECK LAYOUT AND STRUCTURE							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
1.1.1	The flight deck, including any fitted instructor or observer seat, shall be in a distraction-free environment. 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 seats.	√	√	√			√
1.1.2	A physical full-scale replica of the flight deck of the aircraft (type and variant) being simulated including structure, shell, bulkheads, and panels; circuit breakers; flight instruments; navigation, communication, and similar use equipment; caution and warning systems; emergency equipment and all other equipment and systems with associated controls and observable flight deck indicators. 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 aircraft. The shell may be open to the rear.			√			√
1.1.3	The flight deck shall be characteristic of the simulated aircraft type. The enclosure may be limited to the flight deck panels and instruments (without the flight deck structure), or may be a perceived flight deck shell.		√				√

1: FLIGHT DECK LAYOUT AND STRUCTURE							
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**		
		G	**R**	**S**	**QTG(A)**	**QTG(H)**	**F&S**
1.1.4	A flight deck area which shall be characteristic of the simulated aircraft class or group. The enclosure may be limited to the flight deck panels and instruments (without the flight deck structure).	√					√
1.1.5	A flight deck which is characteristic of the simulated aircraft class or group may have physical dimensions such that the enclosure may be acceptable to simulate more than one group of aircraft in a convertible FSTD. Each FSTD conversion shall be characteristic of the group of aircraft being simulated which may require some controls, instruments, panels, masking, etc. to be changed for some conversions	√					√
1.2	FLIGHT DECK WINDOWS						
1.2.1	Windows, eyebrow and chin windows, etc., shall be replicated at the correct positions. The glazing shall provide the reflection effects for the simulated aircraft where applicable, e.g. instrument reflections in night flight conditions, mirroring effects. As applicable, equipment for operation of the flight deck windows shall be included but the actual windows need not be operable.			√			√
1.2.2	Any window accessories and other aircraft parts visible within the visual field of view that obstructs the view or has a functional use (e.g. wipers, demisting wiring, pitot tubes, handles, wire-cutters, external mirrors, ice detectors) shall be fitted, as applicable to the aircraft. A non-functional replica, silhouette, or visual representation is acceptable.			√			√
1.3	FLIGHT DECK EQUIPMENT						
1.3.1	Additional required flight crew member duty stations and those required bulkheads aft of the pilots' seats containing items such as switches, circuit breakers and supplementary radio panels, to which the flight crew may require access during any event after pre-flight flight deck preparation is complete, are also considered part of the flight deck and shall replicate the aircraft.		√	√			√

1: FLIGHT DECK LAYOUT AND STRUCTURE							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
1.3.2	Flight deck elements and equipment that are accessed by the flight crew during normal, abnormal, emergency and non-normal operations, where applicable, shall function to the extent required to replicate the aircraft during that procedure(s). Anything not required to (e.g. flight deck panels or functions to be used only by aircraft maintenance personnel), does not need to be functional and are not required to be supported in the simulation, but any visible hardware and associated controls and switches shall be fitted.		✓	✓			✓
1.3.3	Items required to be accessed by the flight crew, such as landing gear pin storage compartments, fire axes or extinguishers, spare light bulbs and aircraft document pouches, or reasonable facsimile, shall be available but may be relocated to a suitable location as near as practical to the original position; otherwise, they may also be omitted. Fire axes and any similar purpose equipment shall be omitted or be represented in silhouette or by a photograph or a similar technique. Bulkheads containing only such items may be omitted.		✓	✓			✓
1.4	FLIGHT DECK PANELS, INSTRUMENTS AND SWITCHES Note: As presented in CS FSTD.QB.104, the individual aircraft system operation may be at different fidelity levels (N/G/R/S). Where an aircraft system is not simulated, the associated panel(s), switches and hardware need not be simulated, or they may be representations that do not support interaction.						
1.4.1	The flight deck instruments, panels and switches shall support all the aircraft systems that are simulated. Simultaneous interaction of them shall be possible. Basic flight instruments, as applicable to the simulated aircraft, shall be fitted.	✓	✓	✓			✓
1.4.2	Flight deck structures, instruments, panels and switches shall be properly located, replicating that in the particular aircraft type and variant.			✓			✓

1: FLIGHT DECK LAYOUT AND STRUCTURE							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
1.4.3	The flight deck instruments, panels and switches, for the aircraft systems which are simulated shall be represented in the flight deck in a spatially characteristic layout for the simulated aircraft type (i.e. the distance between instruments and switches and the location relative to the pilot seats such that any deviations in the location and size of panels, instruments and switches shall not distract the pilots in the flow of their tasks or in operating the panels, instruments and switches).		✓				✓
1.4.4	Flight deck instruments, panels and switches shall be characteristic of the simulated aircraft class or group (as applicable).	✓					✓
1.4.5	The appearance of the simulated instrument, when viewed from the principal flight crew member’s angle, shall replicate that of the actual aircraft instrument.		✓	✓			✓
1.4.6	Any instrument reading inaccuracy due to viewing angle and parallax present in the actual aircraft instrument shall be replicated in the simulated instrument display image. Any non-realistic induced viewing angle error and parallax shall be minimised on shared instruments such as engine displays and standby indicators.		✓	✓			✓

1: FLIGHT DECK LAYOUT AND STRUCTURE								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
1.4.7	The use of electronically displayed images with physical overlay or masking for FSTD instruments and/or instrument panels is acceptable, provided: (1) all instruments and instrument panel layouts are dimensionally correct with differences, if any, being imperceptible to the pilot. (2) instruments replicate those of the aircraft including full instrument functionality and embedded logic, if any. (3) instruments displayed are free of quantisation (stepping). (4) instrument display characteristics replicate those of the aircraft including resolution, colours, luminance, fonts, fill patterns, line styles and symbology. The brightness shall correspond to the appropriate lighting control setting; the maximum brightness shall be tuned to the simulator lighting conditions; overlay or masking, including bezels and bugs, as applicable, replicates the aircraft panel(s). (5) instrument controls and switches replicate and operate with the same technique, effort, travel and in the same direction as those in the aircraft. (6) as applicable, instruments shall have faceplates that replicate those in the aircraft. (7) for three-dimensional instruments, such as an electro-mechanical instrument, the display image shall appear to have the same perceived three-dimensional depth as the replicated instrument. The appearance of the simulated instrument, when viewed from any angle, shall replicate that of the actual aircraft instrument. Any instrument reading inaccuracy due to viewing angle and parallax present in the actual aircraft instrument shall be duplicated in the simulated instrument display image; (8) typical vibrations as the instrument in the aircraft.		✓				✓

1: FLIGHT DECK LAYOUT AND STRUCTURE								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
1.4.8	All flight deck circuit breakers shall replicate those in, and be located as in, the aircraft. Only those circuit breakers used in a normal, abnormal, or emergency procedure need to be presented, simulated in an aircraft-like form, and be functionally accurate. The tactile feel, technique, effort, and direction required to manipulate the circuit breakers shall replicate those in the aircraft.			✓			✓
1.4.9	A representative circuit breaker panel(s) shall be presented (photographic reproductions are acceptable) and located in a spatially representative location(s). Only those circuit breakers used in a normal, abnormal or emergency procedure need to be simulated, in a class representative form, and be functionally accurate.		✓				✓
1.4.10	Only those circuit breakers used in a normal, abnormal or emergency procedure need to be presented, simulated in an aeroplane-like form, and be functionally accurate.	✓					✓
1.5	FLIGHT DECK HAPTIC REQUIREMENTS						
1.5.1	Flight deck instruments, panels and switches shall replicate the aircraft type and variant in shape, operation, and tactile feel, including three-dimensional geometry, range of travel, force, and other mechanical characteristics.			✓			✓
1.5.2	Where tactile hardware is fitted in the FSTD, flight deck instruments, panels and switches shall be similar to the aircraft type in shape, operation, and tactile feel, including three-dimensional geometry, range of travel, force, and other mechanical characteristics.		✓				✓
1.5.3	Where tactile hardware is fitted in the FSTD, flight deck instruments, panels and switches shall be aircraft-like, as per aircraft class or group, in shape, operation, and tactile feel.	✓					✓
1.5.4	Where touchscreen representations of three-dimensional switches, panels or instruments are fitted in the FSTD, flight deck instruments, panels and switches shall be similar to the aircraft type in three-dimensional appearance and operation, including the range of travel (where applicable).		✓				✓

1: FLIGHT DECK LAYOUT AND STRUCTURE								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
1.5.5	Where touchscreen representations of three-dimensional switches, panels or instruments are fitted in the FSTD, flight deck instruments, panels and switches shall be aircraft-like, as per aircraft class or group, in appearance and operation.	✓					✓
1.5.6	Where touchscreen representations of three-dimensional controls are fitted in the FSTD, the operation of any touch controls shall be efficient and not distracting to the crewmembers.	✓	✓				✓
1.6	INSTRUMENT LIGHTING REQUIREMENTS						
1.6.1	Instrument lighting shall replicate that of the aircraft; it shall be operated from the same control (e.g., lighting panel) as in the aircraft; the logic of operation, e.g. the type of illumination dimmed with one particular button, shall be as per the aircraft.			✓			✓
1.6.2	Lighting environment for panels and instruments shall be sufficient for the operation of the flight deck instruments. Back-lighted panel and instrument lighting may be installed.	✓	✓				✓
1.7	FLIGHT CREW MEMBER SEATING						
1.7.1	Flight crew member seats and the movement mechanism shall replicate those in the aircraft being simulated.			✓			✓
1.7.2	Flight crew member seats shall be characteristic of those in the aircraft being simulated. They shall afford the capability for the occupants to be able to achieve the design eye reference position established for the simulated aircraft. Aircraft flight deck observer seats are not considered to be additional flight crew member duty stations and may be omitted.		✓				✓
1.7.3	Flight crew member seats shall provide the crew member(s) with a characteristic design eye position and have sufficient adjustment to allow the occupant to achieve proper posture at the simulated instruments, panels, switches and flight controls as appropriate for the class or group of aircraft.	✓					✓

1: FLIGHT DECK LAYOUT AND STRUCTURE								
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**		
		G	**R**	**S**	**QTG(A)**	**QTG(H)**	**F&S**
1.8	FLIGHT DECK LIGHTING						
1.8.1	Flight deck lighting shall replicate that in the aircraft and shall not cause unrealistic reflections on flight deck systems (e.g. NVG).			√			√
1.8.2	Lighting environment for panels and instruments shall be sufficient for their operation. Back-lit panels and instrument lighting may be installed but are not required.	√	√				√
1.9	SIMULATED AMBIENT LIGHTING						
1.9.1	The flight deck ambient lighting, where fitted, shall be dynamically consistent (e.g. the light level is correlated with the environmental brightness) with the visual display. The ambient lighting shall provide an even level of illumination which is not distracting to the flight crew member(s).			√			√
1.9.2	The ambient lighting shall provide an even level of illumination that is not distracting to the flight crew member(s).		√				√
1.9.3	The readability of the instruments, charts, etc. shall be ensured at all times, where ambient lighting is not fitted.	√	√	√			√
1.10	XR SYSTEMS: VIRTUAL FLIGHT DECK REQUIREMENTS Requirements for flight decks fully or partially perceived through an HMD Note: Requirements marked with √[1] indicate that an objective test section for these is not available. The tests shall be defined in the Special Conditions.						

1: FLIGHT DECK LAYOUT AND STRUCTURE							
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**		
		G	**R**	**S**	**QTG(A)**	**QTG(H)**	**F&S**
1.10.1	Type and variant specific FSTDs require a perceived full-scale physical flight deck replica of the aircraft represented with all elements in hardware for pilot interaction (including physical flight controls). This includes other physical structural elements (e.g. frame, other seats, doors) of the flight deck structure that impact the pilot's movement (as applicable to training). The entire flight deck and relevant aircraft parts shall be visually perceivable by the pilot. Haptic feedback shall be specific to the aircraft simulated.			✓			✓
1.10.2	The flight deck shall be a perceived full scale replica representative of the aircraft simulated with all elements in hardware for pilot interaction. Other structural elements (e.g. frame, other seats, doors) shall be implemented to the extent relevant for training. The entire flight deck and relevant aircraft parts shall be visually perceivable by the pilot. Primary flight controls shall be physically implemented. Touch panels are acceptable to represent flight deck elements if training is not adversely affected.		✓				✓
1.10.3	Primary flight controls shall be physically implemented. Other elements may be operable by alternate means such as gesture control. Methods used shall not adversely affect training. The entire flight deck and relevant aircraft parts shall be visually perceivable by the pilot.	✓					✓
1.10.4	Acceptable means for using checklists and maps shall be provided in the virtual environment.		✓	✓			✓
1.10.5	The flight deck representation shall be aligned with implemented physical structures with respect to eyepoint, view and geometry. If a motion system is fitted, the tracking shall be robust against effects of motion.	✓	✓	✓	✓[1]	✓[1]	✓
1.10.6	Flight deck states of implemented hardware and visual representation of these elements (such as switches, levers, guards) shall be consistent with the simulation.	✓	✓	✓			✓

1: FLIGHT DECK LAYOUT AND STRUCTURE							
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**		
		G	**R**	**S**	**QTG(A)**	**QTG(H)**	**F&S**
1.10.7	The virtual flight deck shall represent the simulated aircraft. Dimensions, colours, lighting and behaviour of flight deck elements, controls and equipment shall be accurate. Special attention shall be paid to the correct representation of optical indicators (e.g., warning lights). A list of instrument/indicator colours with physical colour reference and representation target values on the FSTD shall be provided.		✓	✓	✓[1]	✓[1]	✓
1.10.8	The effects of lights, shadows and reflections in the flight deck shall be realistic.		✓	✓			✓
1.10.9	The representation of the flight deck, colours, and simulated light effects (shadows, reflections) shall be consistent and not susceptible to interference from light sources independent of the simulation.	✓	✓	✓			✓
1.10.10	Relevant flight deck colours shall replicate the aircraft simulated			✓			✓
1.10.11	The instructor station shall provide means to observe states of flight deck elements (e.g. switches, panels, displays, instruments) in the virtual environment.	✓	✓	✓			✓
1.10.12	If a direct view is not possible (e.g. when using VR systems), pilot's own body pose (e.g. hands) needs to be represented in the virtual environment (as required by the training tasks). Where there are multiple crew members, they shall be able to see each other's body pose in the virtual environment. For multiple crew training the specifications of the crew member visualisations within the virtual environment shall be described in Special Conditions.		✓	✓			✓
1.10.13	All relevant systems for the flight deck perception (visual system, flight deck hardware, body pose tracking) shall be aligned and stable during operation.	✓	✓	✓			✓
1.11	XR SYSTEMS: HEAD TRACKING SYSTEM Note: Requirements marked with ✓[1] indicate that an objective test section for these is not available. The tests shall be defined in the Special Conditions.						

1: FLIGHT DECK LAYOUT AND STRUCTURE								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
1.11.1	The XR system shall include a head mounted display with accurate head tracking.	√	√	√			√
1.11.2	The tracking of the HMD shall be fast and robust. Tracking noise, glitches and other disruptive effects shall not be present during the operation.	√	√	√			√
1.11.3	Where a motion system is fitted, effects of motion shall not noticeably affect the head tracking or inaccurately impact the pilot's view.	√	√	√	√[1]	√[1]	√
1.11.4	The visual (virtual) flight deck in the HMD shall always be aligned with the flight deck hardware.		√	√			√
1.11.5	The head tracking shall have 6 DoF and accurately change the viewpoint in the flight deck.	√	√	√			√

GM1 CS FSTD.QB.101 FSTD general requirements for Flight Deck Layout And Structure

Summaries of the fidelity levels for the Flight Deck Layout And Structure feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.101.

1: FLIGHT DECK LAYOUT AND STRUCTURE
Specific: A physical full-scale replica of the flight deck of the aircraft (type and variant) being simulated. Flight deck instruments, structures, panels and switches are properly located, replicating that in the particular aircraft type and variant. (Note: This feature excludes the flight controls.)
Representative: The flight deck panels, instruments, and switches, for the aircraft systems which are simulated are represented in the flight deck in a spatially characteristic layout for the simulated aircraft type. The enclosure may be limited to the flight deck panels and instruments (without the flight deck structure), or may be a perceived flight deck shell. (Note: This feature excludes the flight controls.) Switches, panels or instruments may be simulated by using either tactile hardware or touchscreen representations.
Generic: A flight deck area which is characteristic of the simulated aircraft class or group. Flight deck instruments, panels and switches are characteristic of the simulated aircraft class or group. The enclosure may be limited to the flight deck panels and instruments (without the flight deck structure). (Note: This feature excludes the flight controls.) Switches, panels or instruments may be simulated by using either tactile hardware or touchscreen representations.

GM2 CS FSTD.QB.101 Representative Flight Deck Layout And Structure

Each FSTD should have the basic flight instruments, as applicable to the simulated aircraft. These mean the primary flight instruments such as attitude indicator, altimeter, airspeed indicator, vertical speed indicator, turn coordinator, heading indicator (directional gyro), or other representations of these, such as primary flight display (PFD) and navigation display (ND), or electronic flight instrument system (EFIS) as applicable to the simulated aircraft.

At Specific fidelity level, these should replicate the simulated aircraft type and variant. At Representative fidelity level, these should be characteristic of the simulated aircraft type, i.e. simulate such an instrument arrangement that can be installed in a real aircraft of this type. At Generic fidelity level, these should be characteristic of the simulated aircraft class or group. The markings (e.g. limits) should be characteristic of the simulated aircraft and should correspond to the flight dynamics model. For example, the airspeed indicator's marking for best rate of climb speed should match the airspeed that gives the best rate of climb in the FSTD in nominal conditions. Similarly for minimum control speed and so on.

For this feature, the basic flight instruments are considered as an entity where all the instruments are at the same fidelity level to ensure positive transfer of training. If the fitted instruments are simulated at different fidelity levels, the entity should be considered to be only at the level of the lowest simulated instrument.

FLIGHT CONTROL FORCES AND HARDWARE (CLH)

CS FSTD.QB.102 FSTD general requirements for Flight Control Forces And Hardware (CLH)

2: FLIGHT CONTROL FORCES AND HARDWARE
Defines the physical, flight controls appearance, travel, tactile feel, and force feedback operation. Note: Primary flight controls are the controls that are required for immediate control of the aircraft. For a typical aeroplane, typically identified as column, wheel, pedal, engine/thrust control levers (e.g. throttles, propeller levers, etc.), tiller and toe brakes. For a typical helicopter, identified as cyclic, collective and pedals. Note: The individual flight controls may be at different fidelity levels (N/G/R/S).

The general requirements for the Flight Control Forces and Hardware feature are presented in the table below (where hardware is fitted).

2: FLIGHT CONTROL FORCES AND HARDWARE								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
2.1	PRIMARY CONTROL FORCES AND TRAVEL						
2.1.1	Primary flight controls shall be fitted that are characteristic in appearance and tactile feel of the simulated aircraft type and variant. Primary flight control forces and travel shall react in the same manner as in the simulated aircraft type and variant under the same flight and system conditions throughout the flight envelope.			✓	2.a	2.a	✓

2: FLIGHT CONTROL FORCES AND HARDWARE								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
2.1.2	For aeroplanes: The following requirement applies only to FSTDs that are to be qualified to conduct full stall training tasks. For aeroplanes equipped with a stick pusher system control forces, displacement, and the consequent surface position shall correspond to those of the aeroplane being simulated. The Statement of Justification shall verify that the stick pusher system has been simulated and validated using the aeroplane manufacturer's design data or other acceptable data source. The statement of justification shall 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.			√	2.a.10		√
2.1.3	For aeroplanes: For aeroplanes equipped with a longitudinal control augmentation functionality (e.g. control force modifier), the control forces, the displacement, and surface position shall correspond to those of the aeroplane being simulated. The Statement of Justification shall verify that the relevant system/functionality has been simulated and validated using the aeroplane manufacturer's design data or other acceptable data source. The statement of justification must address, at a minimum, the system/functionality activation and cancellation logic as well as system dynamics, control displacement and forces as a result of the activation.		√	√			√
2.1.4	Primary flight controls shall be fitted that are characteristic in appearance and tactile feel of the simulated aircraft type. Primary flight control forces and travel shall react in the same manner as in the simulated aircraft type under the same flight and system conditions throughout the flight envelope.		√		2.a	2.a	√

2: FLIGHT CONTROL FORCES AND HARDWARE							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
2.1.5	Primary flight controls shall be fitted that are characteristic in appearance and tactile feel of the simulated aircraft class or group. Primary flight control forces and travel shall be characteristic of the simulated class or group. Primary flight control forces do not have to change as flight conditions such as configuration or airspeed changes.	√			2.a	2.a	√
2.2	OTHER FLIGHT CONTROLS Note: This section concerns other flight controls, such as trims, flaps lever, speed brake lever, landing gear lever.						
2.2.1	The flight control hardware shall replicate the simulated aircraft type and variant. The forces, tactile feel and travel shall replicate the simulated aircraft type and variant.			√	2.a	2.a	√
2.2.2	The flight control hardware shall be characteristic of the simulated aircraft type. The forces, tactile feel and travel shall be characteristic of the simulated aircraft type.		√		2.a	2.a	√
2.2.3	The flight control hardware shall be characteristic of the simulated aircraft class or group. The forces, tactile feel and travel shall be characteristic of the simulated aircraft class or group.	√			2.a	2.a	√
2.2.4	Where touchscreen representations of the flight controls are fitted, they shall be aircraft-like, as per aircraft class or group, in appearance and operation. The operation of any touch controls shall be efficient and not distracting to the crewmembers.	√					√
2.3	INTEGRATION WITH AIRCRAFT SYSTEMS						
2.3.1	Integration of the flight controls hardware with the aircraft systems: If an aircraft system affects the primary flight control forces, the primary flight control forces shall be characteristic to the simulated aircraft type (e.g. hydraulic system status affecting the control forces, or force required to overcome the autopilot).		√	√			√

2: FLIGHT CONTROL FORCES AND HARDWARE								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
2.3.2	Integration of the flight controls hardware with the aircraft systems: If an aircraft system affects the flight control forces, the flight control forces shall be characteristic to the simulated aircraft class or group system operation (e.g. hydraulic system status affecting the control forces, or force required to overcome the autopilot).	√					√
2.4	CONTROL FEEL DYNAMICS						
2.4.1	Primary flight control dynamics shall replicate the simulated aircraft type and variant.			√	2.b	2.a	
2.4.2	Primary flight control dynamics shall be characteristic of the simulated aircraft type.		√		2.b	2.a	

GM1 CS FSTD.QB.102 FSTD general requirements for Flight Control Forces And Hardware

Summaries of the fidelity levels for the Flight Control Forces and Hardware feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.102.

2: FLIGHT CONTROL FORCES AND HARDWARE
Specific: Flight controls appearance, tactile feel, forces and travel replicate the simulated aircraft throughout the flight envelope.
Representative: Flight controls appearance, tactile feel, forces and travel are characteristic of the simulated aircraft throughout the flight envelope.
Generic: Flight controls appearance, tactile feel, forces and travel are characteristic of the simulated aircraft class or group. Flight control forces do not have to change as flight conditions such as configuration or airspeed changes.

GM2 CS FSTD.QB.102 FSTD general requirements for Flight Control Forces And Hardware

(a) Flight control forces

For many aircraft, the primary flight control forces or travel vary throughout the flight envelope. For example, when airspeed changes, the flight control forces change. A typical method of simulating this phenomena is to use an active force feedback system where a computer driven system continuously adjusts the simulated flight controls for the pilot to experience appropriate control forces. It may be possible to gain this also by using a passive system where the control forces are created only by a mechanical system (e.g. springs, dampers) but building and validating such a system could have difficulties.

(b) Control augmentation

The words 'longitudinal control augmentation functionality' mean aeroplane functions that modify or enhance the stability and control characteristics. Examples include functions that modify control forces to enhance stick force gradients during speed or angle of attack changes, or stall identification. There are separate aeroplane FSTD requirements for stick pusher systems and for longitudinal control augmentation functionality.

FLIGHT CONTROL SYSTEMS OPERATION (CLO)

CS FSTD.QB.103 FSTD general requirements for Flight Control Systems Operation (CLO)

3: FLIGHT CONTROL SYSTEMS OPERATION
Defines the extent of flight control system functions to be modelled in the FSTD. These include primary flight control surface displacements (e.g. surface position for aeroplanes, blade angles for helicopters), flight control system operation modes and logics, flight and manoeuvre envelope protection functions, flight deck indications and messages.

The general requirements for the Flight Control Systems Operation feature are presented in the table below.

3: FLIGHT CONTROL SYSTEMS OPERATION							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
3.1	PRIMARY FLIGHT CONTROL SYSTEMS OPERATION						
3.1.1	Primary flight control systems shall replicate the simulated aircraft type and variant operation for the normal and any non-normal modes including back-up systems and shall reflect failures of associated systems. Appropriate flight deck indications and messages shall be replicated.			✓			✓
3.1.2	Primary flight control systems shall be characteristic of the simulated aircraft type operation for the normal and any non-normal modes including back-up systems and shall reflect failures of associated systems. Appropriate flight deck indications and messages shall be replicated.		✓				✓
3.1.3	Primary flight control systems shall allow aircraft operation with appropriate flight deck indications.	✓					✓
3.2	PRIMARY FLIGHT CONTROLS OPERATION						

3: FLIGHT CONTROL SYSTEMS OPERATION							
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**		
		G	**R**	**S**	**QTG(A)**	**QTG(H)**	**F&S**
3.2.1	Primary flight control displacements shall generate flight controls surface positions (for aeroplanes) or blade angles (or equivalent, for rotorcraft) that replicate the simulated aircraft type and variant.			✓	2.a	2.a	✓
3.2.2	Primary flight control displacements shall generate flight controls surface positions (for aeroplanes) or blade angles (or equivalent, for rotorcraft) are characteristic of the simulated aircraft type.		✓		2.a	2.a	✓
3.2.3	Primary flight control displacements shall have the control authority that is characteristic of the simulated aircraft class or group.	✓					✓
3.2.4	For CCA aeroplanes: The Statement of Justification shall explain and demonstrate how the primary flight control authority changes as the aircraft configuration changes.	✓	✓	✓			✓
3.3	OTHER FLIGHT CONTROLS OPERATION Note: This section concerns other flight controls, such as trims (pitch, roll, yaw), tiller, toe brakes, flaps lever, speed brake lever, landing gear lever, etc.						
3.3.1	The operation of other flight controls shall replicate the simulated aircraft type and variant.			✓			✓
3.3.2	The operation of other flight controls shall be characteristic of the simulated aircraft type.		✓				✓
3.3.3	The operation of other flight controls shall be characteristic of the simulated aircraft class or group.	✓					✓
3.4	ENVELOPE PROTECTION FUNCTIONS Note: Objective tests are applicable only to CCA.						
3.4.1	The flight control systems functions for flight and manoeuvre envelope protection functionality shall replicate the simulated aircraft type and variant.			✓	2.h		✓
3.4.2	The flight control systems functions for flight and manoeuvre envelope protection functionality shall be characteristic of simulated aircraft type.		✓		2.h		✓

3: FLIGHT CONTROL SYSTEMS OPERATION							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
3.4.3	The flight control systems functions for flight and manoeuvre envelope protection functionality shall be characteristic of the simulated aircraft class/group.	✓					✓
3.5	FLIGHT CONTROLS INTEGRATION WITH AIRCRAFT SYSTEMS						
3.5.1	For aeroplanes: For aeroplanes equipped with a longitudinal control augmentation functionality (e.g. control force modifier), the surface positions shall correspond to those of the aeroplane being simulated. The statement of justification shall verify that the relevant system/functionality has been modelled, programmed, and validated using the aeroplane manufacturer's design data or other acceptable data source. The statement of justification must address, at a minimum, the system/functionality activation and cancellation logic as well as system dynamics, control displacement and forces as a result of the activation.		✓	✓			✓
3.5.2	Integration of the primary flight control system operation with the aircraft systems: If an aircraft system (e.g. autoflight control system) affects the primary flight control system, the primary flight control system operation shall correspond to the simulated aircraft system operation (e.g autopilot may move the flight controls, automatically trim the flight controls, or move the actuators). The Statement of Justification shall describe whether or not the primary flight controls system is simulating a computer controlled aircraft, and whether or not the effects of reversible flight controls are modelled, and in which axes.		✓	✓			✓

3: FLIGHT CONTROL SYSTEMS OPERATION								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION			
		G	R	S	QTG(A)	QTG(H)	F&S	
3.5.3	Integration of the primary flight control system operation with the aircraft systems: If an aircraft system (e.g. autoflight control system) affects the primary flight control system, the primary flight control system operation shall be characteristic to the simulated aircraft class or group system operation (e.g autopilot may move the flight controls, automatically trim the flight controls, or move the actuators). The Statement of Justification shall describe which aircraft systems affect the primary flight controls and identify what autopilot system is being simulated. This shall include if the system is modelling a computer controlled aircraft, and whether the effects of reversible flight controls are modelled, and in which axes.	√					√	

GM1 CS FSTD.QB.103 FSTD general requirements for Flight Control Systems Operation

Summaries of the fidelity levels for the Flight Control Systems Operation feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.103.

3: FLIGHT CONTROL SYSTEMS OPERATION
Specific: Primary flight control displacement generates primary flight control surface positions (for aeroplanes) or blade angles (for rotorcraft) as in the aircraft type and variant under the same flight and system conditions. Flight control systems operation replicates aircraft operation for normal and any non-normal modes including back-up systems and reflects failures of associated systems. Appropriate flight control system logic, flight deck indications and messages are replicated.
Representative: Primary flight control displacement generates primary flight control surface positions (for aeroplanes) or blade angles (for rotorcraft) that are similar to the aircraft type being simulated under the same flight and system conditions. Flight control systems operation and logic are as in the simulated aircraft type, including system interdependencies, for normal and any non-normal modes. This includes back-up systems and reflects failures of associated systems of the aircraft type. Appropriate flight deck indications and messages are represented.
Generic: Primary flight control displacement generates a surface movement that is characteristic of the simulated aircraft class or group. Allows aircraft operation with appropriate flight deck indications.

GM2 CS FSTD.QB.103 Guidance on primary flight controls operation

This GM gives guidance on primary flight controls operation.

(a) As CS FSTD.QB.103 requires, at fidelity levels S and R the objective tests in section 2.a should validate flight controls surface positions (for aeroplanes) or blade angles (or equivalent, for rotorcraft). For aeroplane FSTDs this is straight-forward and self-explanatory. For rotorcraft FSTDs, the simulation may be based on different models and may not even use the exact blade angle as part of the flight dynamics model (e.g. disc model may be used). However, successful model development typically requires that the flight control position vs. rotor position is measured during the data gathering process. The data gathering may record the flight control position (e.g. cyclic) vs. blade angles, actuator positions and/or swashplate attitude. It is acknowledged that the FSTD model may not perfectly match the measured rotor blade angle (or equivalent) in 2.a objective tests because of the complexity of the rotorcraft flight dynamics and flight control models. For rotorcraft, the resulting aircraft response vs. flight control input is of greater importance and is validated by a multitude of objective tests. The 2.a objective tests should still demonstrate the rotor blade angle (or equivalent) vs. flight control input for the above mentioned reasons and to demonstrate the repeatability of the flight control system for recurrent test purposes.

(b) As CS FSTD.QB.103 requires, at fidelity level G the primary flight control displacements should have authority that is characteristic of the simulated aircraft class or group. At this fidelity level, the simulation may be simplified and may not consider flight control surface positions for aeroplanes or blade angles (or equivalent) for rotorcraft. Because of this, it is required that the authority of the primary flight controls is characteristic of the simulated aircraft class or group. The word 'authority' should be understood to mean the surface position or blade angle (or equivalent) similarly as for fidelity levels R and S, or the aircraft response (e.g. pitch rate vs. pitch flight control input) as applicable to the used simulation method. The Statement of Justification should explain the simulation of the primary flight control system and how the resulting aircraft response is calculated.

(c) For rotorcraft, the flight control system may use multiple actuators with different rates and logics by using multiple inputs. Simulation of the whole system should be characteristic of the simulated rotorcraft group. Due to non-linearities and possible actuator saturation, the flight controls of rotorcraft/helicopters may have varying authority depending on the flight state.

GM3 CS FSTD.QB.103 Flight Control Systems Operation at Generic fidelity level

This GM gives guidance on Flight Control Systems Operation feature at Generic fidelity level.

(a) Different aircraft use different primary flight controls systems. The system may for example be reversible or irreversible, include stabilisation augmentation, include flight envelope protection systems, include automatic trim functions, or the aircraft may be a fly-by-wire computer controlled aircraft (CCA). When the flight controls systems operation is at Generic fidelity level and the simulated aircraft class or group has complex flight control systems, then the FSTD's flight control operation is required to have realistic characteristics and should be similar to a real aircraft that exists within the simulated aircraft class or group. This should be demonstrated in the Statement of Justification. For example, for a fast fly-by-wire jet aeroplane equipped with a stabiliser, the pitch controller input may lead to a deflection of the elevator followed by an auto-trim function on the stabiliser. The logics and gains of these functions should be appropriate.

(b) Simulation of computer controlled aircraft (CCA) or flight envelope protection systems should integrate with other features. The associated secondary flight controls, flight deck panels, annunciations and indications should correlate with the Flight Control Systems Operation. The rate and sequence of any automatic trim functions should be realistic.

(c) It is possible that for CCA aeroplanes, the same flight control input results in different authority (i.e. different magnitude of surface deflections) for different configurations. This means that the results of objective tests such as 2.a.1, 2.a.2 and 2.a.3 may have different slopes and results when the tests are performed for different flap settings. This affects the feel or sensitivity of the aircraft. The Engineering Report should demonstrate this by providing plots of the controller sweeps vs. surface positions for all the different flap settings.

(d) Simulation of the failures of complex flight controls systems (e.g. loss of stabilisation system, reversion mode of CCA, etc.) should have an effect on the performance and handling characteristics. The features should integrate and provide positive transfer of training.

(e) While this feature at the Generic fidelity level does not have to simulate a certain aircraft, it should be characteristic of the simulated aircraft class or group and include associated phenomena and effects. For the Generic fidelity level, it should be demonstrated that an aircraft within the simulated class or group exists with similar flight control system operation as the FSTD. It should be noted that simulation of complex aircraft is complex even at the Generic fidelity level.

GM4 CS FSTD.QB.103 Integration of the flight control system with the autoflight control system

This GM gives guidance on integration of the flight control system with the autoflight control system.

(a) CS FSTD.QB.010 allows that the individual aircraft systems may be at different fidelity levels. GM1 CS FSTD.QB.010 further explains that the individual aircraft systems cannot always be treated in isolation since they often integrate with other systems. The aircraft systems requirements are presented in CS FSTD.QB.104.

(b) For a real aircraft, the autoflight control system may be an integrated and inseparable part of the flight control system. Many helicopters and larger aeroplanes have such integrated systems. In addition to the autoflight modes or upper modes (e.g. HDG, ALT, IAS, NAV, etc.), such integrated systems may provide stabilisation (e.g. different levels of stability augmentation, SAS) and protections. For such an integrated system, based on the references above, the FSTD should have the autoflight control system simulation and the Flight Controls System Operation feature at the same or higher fidelity level (G/R/S). The Statement of Justification should identify what autoflight control system is being simulated.

AIRCRAFT SYSTEMS (SYS)

CS FSTD.QB.104 FSTD general requirements for Aircraft Systems (SYS)

4: AIRCRAFT SYSTEMS
Defines the extent of aircraft systems simulation required to be modelled in the FSTD. The requirements apply where the appropriate systems are simulated. This feature concerns the operation, functionalities and indications of the aircraft systems and interdependencies of different systems. Note: Aircraft systems mean for example instruments, communications, navigation, autopilot, flight director, flight management, flight guidance, hydraulic, electrical, fuel, pneumatic, pressurisation, air conditioning, powerplant, auxiliary power unit, caution and warning systems, fire protection, ice and rain protection, surveillance, TAWS/GPWS/EGPWS, ACAS/TCAS, WXR, and other systems. Note: See CS FSTD.QB.120 for systems required for multi-crew co-operation (MCC) training and operation. Note: The individual aircraft systems may be at different fidelity levels (N/G/R/S). Note: This feature excludes the flight controls. See features 'Flight Control Forces And Hardware' in CS FSTD.QB.102 and 'Flight Controls System Operation' in CS FSTD.QB.103 for their requirements. Note: See 'Flight Deck Layout And Structure' feature in CS FSTD.QB.101 for the requirements on the aircraft system hardware/interface requirements. Note: See features 'Performance And Handling' in CS FSTD.QB.105 - 107, 'Vibration Cueing' in CS FSTD.QB.109, 'Motion Cueing' in CS FSTD.QB.110, 'Sound Cueing' in CS FSTD.QB.108 and 'Visual Cueing' in CS FSTD.QB.111 for the requirements on the effects associated with aircraft systems operation (e.g. activation of anti-icing system may result in a change in aircraft flight performance and handling, and vibration, motion, sound and visual cues).

The general requirements for the Aircraft Systems feature are presented in the table below.

4: AIRCRAFT SYSTEMS							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
4.1	AIRCRAFT SYSTEMS OPERATION					
4.1.1	Aircraft systems shall replicate the simulated aircraft type and variant with functionality for flight crew operation, including system interdependencies. Once activated, correct normal system operation shall result from system management by the flight crew and not require input from the instructor's controls. Systems shall be operative to the extent that all normal, abnormal, and emergency operating procedures can be accomplished.			✓		✓
4.1.2	Aircraft systems shall be representative of the simulated aircraft type with sufficient functionality for flight crew operation, including system interdependencies. Once activated, correct normal system operation shall result from system management by the flight crew and not require input from the instructor's controls. Systems shall be operative to the extent that appropriate normal, abnormal, and emergency operating procedures can be accomplished.		✓			✓
4.1.3	Aircraft systems shall be characteristic of the simulated aircraft class or group of aircraft and shall have sufficient functionality for flight crew operation, including system interdependencies. Once activated, appropriate normal system operation shall result from system management by the flight crew and not require input from the instructor's controls. System functionality shall enable sufficient normal and, where applicable, emergency, and abnormal operating procedures to be accomplished.	✓				✓
4.1.4	Circuit breakers for the simulated aircraft systems that are required for systems operation shall be functional.			✓		✓
4.1.5	The aircraft systems are to include EVS, night vision goggles, if required by the aircraft type and variant certification.			✓		✓

4: AIRCRAFT SYSTEMS							
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**	
		G	**R**	**S**	**QTG**	**F&S**
4.1.6	Integration of the aircraft systems: Aircraft systems shall be correctly integrated with all other FSTD features.	✓	✓	✓		✓
4.2	AIRCRAFT SYSTEMS SIMULATION BASIS					
4.2.1	The design basis, including data references where applicable, for the simulation of the relevant aircraft systems by the TDM shall be summarised in the Engineering Report in terms of the following: 1. Extent of aircraft system simulation (Full or partial functionality/capability with respect to accomplishing all normal, abnormal and/or emergency procedures); 2. Aircraft system simulation technique: a. TDM own modelling; b. Aircraft OEM provided modelling (executable, binary or LSAP); c. Aircraft hardware or LRU; d. Rehosting or retargeting of aircraft OEM or avionics vendor software; e. Reverse engineering; f. Other modelling approaches as defined by the TDM.	✓	✓	✓		
4.3	AIRCRAFT SYSTEMS DATABASES					
4.3.1	Where the aircraft system uses a database (e.g. FMS or GPS navigation database, chart view, EGPWS/TAWS terrain or obstacle data, magnetic variation database, performance database, etc.), the database shall be valid and appropriate to support the system operation to the applicable fidelity level (G/R/S) of the system. For the databases associated with navigation functions (e.g. FMS or GPS navigation database), the database shall cover the same areas and operating sites as the simulation of the navigation feature.	✓	✓	✓		✓
4.4	INSTRUMENT INDICATIONS					

4: AIRCRAFT SYSTEMS						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
4.4.1	All relevant instrument indications involved in the simulation of the aircraft type and variant shall automatically respond to attitude changes of the aircraft, pilot inputs or changes in system status, as well as to any external stimulus relevant for the instrument or indication being simulated. The instrument simulation shall replicate the real instruments and their inherent errors. These errors shall include but are not limited to atmospheric conditions and disturbances, effects resulting from icing, barometric altimeter error due to outside air temperature, magnetic compass turn and acceleration errors, latency of barometric altimeter, inaccuracies of radio navigation instruments, etc. Numerical values shall be presented in the units used in the simulated aircraft type and variant.			✓		✓
4.4.2	All relevant instrument indications involved in the simulation of the aircraft type shall automatically respond to attitude changes of the aircraft, pilot inputs or changes in system status, as well as to any external stimulus relevant for the instrument or indication being simulated. The instrument simulation shall be characteristic to the real instruments and their inherent errors. These errors shall include but are not limited to atmospheric conditions and disturbances, effects resulting from icing, barometric altimeter error due to outside air temperature, magnetic compass turn and acceleration errors, latency of barometric altimeter, inaccuracies of radio navigation instruments, etc. Numerical values shall be presented in the units used in the simulated aircraft type.		✓			✓
4.4.3	All relevant instrument indications involved in the simulation of the aircraft shall automatically respond to attitude changes of the aircraft, pilot inputs or changes in system status. The instrument simulation shall be characteristic of simulated aircraft class or group and include the inherent errors of the instruments. These errors shall include but are not limited to atmospheric conditions and disturbances, effects resulting from icing, barometric altimeter error due to outside air temperature, magnetic compass turn and acceleration errors, latency of barometric altimeter, inaccuracies of radio navigation instruments, etc.	✓				✓

4: AIRCRAFT SYSTEMS							
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**	
		G	**R**	**S**	**QTG**	**F&S**
4.5	COMMUNICATIONS, NAVIGATION AND CAUTION AND WARNING SYSTEMS					
4.5.1	Communications, navigation, caution and warning equipment, avionics sounds associated with aircraft systems operations, including audio warnings and other aural cues fed through headsets, corresponding to that installed in the simulated aircraft type and variant shall operate within the operational tolerances (as applicable to the real aircraft) and aircraft characteristics prescribed for the applicable aircraft systems. (Applies where the appropriate systems are simulated.)			✓		✓
4.5.2	Communications, navigation, and caution and warning equipment, avionics sounds associated with aircraft systems operations, including audio warnings and other aural cues fed through headset corresponding to that typically installed in the simulated aircraft type shall operate within operational tolerances and aircraft characteristics for the applicable aircraft systems. (Applies where the appropriate systems are simulated.)		✓			✓
4.5.3	Communications, navigation, and caution and warning equipment, avionics sounds associated with aircraft systems operations, including audio warnings and other aural cues fed through headset characteristic of the simulated aircraft class or group shall operate within operational tolerances and aircraft characteristics for the applicable aircraft systems. (Applies where the appropriate systems are simulated.)	✓				✓
4.6	ANTI-ICING SYSTEMS					
4.6.1	Anti-icing systems replicating those installed in the simulated aircraft type and variant shall operate with appropriate effects upon ice formation on airframe, engines, and instrument sensors.			✓		✓
4.6.2	Anti-icing systems corresponding to those typically installed in the simulated aircraft type shall be operative.		✓			✓
4.6.3	Simplified airframe and engine systems, corresponding to those typically installed on the simulated aircraft class or group.	✓				✓

4: AIRCRAFT SYSTEMS						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
4.7	POWERPLANT SYSTEMS					
4.7.1	Powerplant systems shall replicate the simulated aircraft type and variant with functionality for flight crew operation in normal, abnormal, and emergency operations.			✓		✓
4.7.2	Powerplant systems functionality shall enable appropriate normal, abnormal and emergency operating procedures for the simulated aircraft type to be accomplished.		✓			✓
4.7.3	Powerplant systems functionality shall enable sufficient operating procedures for the simulated aircraft class or group to be accomplished including effects of malfunctions.	✓				✓
4.8	INSTRUCTOR CONTROLS					
4.8.1	Instructor controls shall be provided to control all appropriate system variables and insert all abnormal or emergency conditions into the simulated aircraft systems. Simulated malfunctions shall result in integrated system responses with system interdependencies and allow exercising the procedures in relevant operating manuals.			✓		✓
4.8.2	Instructor controls shall be provided to control all appropriate system variables and insert appropriate abnormal or emergency conditions into the simulated aircraft systems. Simulated malfunctions shall allow exercising the procedures in relevant operating manuals.		✓			✓
4.8.3	Instructor controls shall be provided to control all appropriate system variables and insert sufficient abnormal or emergency conditions into the simulated aircraft systems. Simulated malfunctions shall result in integrated system responses with system interdependencies characteristic of the simulated aircraft class or group.	✓				✓

GM1 CS FSTD.QB.104 FSTD general requirements for Aircraft Systems

Summaries of the fidelity levels for the Aircraft Systems feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.104.

4: AIRCRAFT SYSTEMS
Specific: Simulated aircraft systems replicate the particular aircraft type system operation with appropriate system interdependencies. Simulated systems are operative to the extent that all normal, abnormal, and emergency operating procedures can be accomplished.
Representative: Simulated aircraft systems operation and logic are as in the simulated aircraft type, including system interdependencies. Simulated systems are operative to the extent that appropriate normal, abnormal, and emergency operating procedures can be accomplished.
Generic: Simulated aircraft systems are characteristic of the systems used in the simulated aircraft class or group, and have functionality to enable sufficient normal and, where applicable, emergency, and abnormal operating procedures to be accomplished.

GM2 CS FSTD.QB.104 FSTD general requirements for flight instruments

(a) The basic flight instruments are defined in GM2 CS FSTD.QB.101. For the Aircraft Systems feature, they should be considered as an entity where all the instruments are at the same fidelity level to ensure positive transfer of training. If the fitted basic flight instruments are simulated at different fidelity levels, the entity should be considered to be only at the fidelity level of the lowest simulated instrument.

(b) At the Generic fidelity level, the flight instruments should be characteristic of the simulated aircraft class or group. It means that the instruments are required to have realistic characteristics and should be similar to a real aircraft that exists within the simulated aircraft class or group. Also, the instrument power sources should comply with the requirements for real aircraft. For example, the airworthiness directives for real aircraft may stipulate that the attitude indicator and turn coordinator must not share the same power source due to redundancy requirements. As a result, it is customary for one of these instruments to be powered by electrical means while the other utilises vacuum power. This should be simulated in an FSTD with the instruments at Generic fidelity level. In the FSTD, in case of failure of one of these power sources, only the instrument(s) powered by the failed source should be affected.

GM3 CS FSTD.QB.104 Aircraft Systems at Representative fidelity level

This GM gives guidance on what is expected of the aircraft system(s) at the Representative level. The differences between the Specific and Representative fidelity levels are based on the following aspects:

(a) For the Specific fidelity level, the general requirements in CS FSTD.QB.104 require that the system replicates the simulated aircraft type and variant with correct functionality. It is expected that for the Specific level all the system simulation aspects function like in the aircraft, i.e. replicate its operation. For the Representative fidelity level, the system is required to be representative of the simulated aircraft type with sufficient functionality.

(1) The word 'representative' here means that the system logics, sequences, indications and operation should be correct, but the latencies (i.e. timings, delays of events) and rates may differ from the simulated aircraft. For example, adjusting the pressurisation system manually should result in correct sequence of valves and pack operation, but the timing of those and of the resulting cabin altitude rate need not replicate the aircraft but they may be only characteristic.

(2) The words 'sufficient functionality' mean that the system may not simulate all the system functionalities or capabilities that the simulated aircraft system has. For example, the flight management system (FMS) may not support 3D approaches, while the real aircraft system would be capable of them. Such differences should be declared in the documentation (see Part-ORA).

(b) The data requirements for the Specific and Representative fidelity levels are different as is presented in CS FSTD.QB.104 and Subpart C. If the data requirements for the Specific fidelity level can't be demonstrated, the aircraft system in question may still comply with the data requirements of the Representative level.

PERFORMANCE AND HANDLING ON GROUND (GND)

CS FSTD.QB.105 FSTD general requirements for Performance And Handling On Ground (GND)

5: PERFORMANCE AND HANDLING ON GROUND (GND)
Defines the mathematical models and associated data to be used to describe the ground handling characteristics, aerodynamic, propulsion, ground reaction and operating site surface conditions required to be modelled in the FSTD whenever the aircraft is in contact with the surface. This includes acceleration, deceleration, turning, braking, and the effects of wind (including crosswind) where relevant to the aircraft (e.g. includes reverse thrust, the effect of the rudder).

The general requirements for the Performance And Handling On Ground feature are presented in the table below.

5: PERFORMANCE AND HANDLING ON GROUND (GND)							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
5.1	GROUND REACTION Reaction of the aircraft upon contact with the ground (e.g. also including ship deck, sea, ditching, as applicable), or ground based infrastructure (e.g. a platform, rig, mooring mast), through its dedicated system during departure and arrival phases. Equipment of the aircraft system to contact ground shall be considered accordingly (landing gear, skids, bumpers, others).						
5.1.1	Ground reaction model that replicates the simulated aircraft type and variant upon contact with the operating site (e.g. ground or ground-based infrastructure) to include, but not be limited to, strut/skid deflections, tyre or skid friction, side forces, and other appropriate parameters, such as weight and speed, necessary to identify the flight condition and aircraft configuration.			✓			✓

5: PERFORMANCE AND HANDLING ON GROUND (GND)								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
5.1.2	Ground reaction model that is characteristic of the simulated aircraft type upon contact with the operating site (e.g. ground or ground-based infrastructure) to include, but not be limited to, strut/skid deflections, tyre or skid friction, side forces, and other appropriate parameters, such as weight and speed, necessary to identify the flight condition and aircraft configuration;		√				√
5.1.3	Ground reaction model that is characteristic of the simulated aircraft class or group upon contact with the operating site (e.g. ground or ground-based infrastructure) to include, but not be limited to, strut deflections, tyre or skid friction, side forces, and other appropriate parameters, such as weight and speed, necessary to identify the flight condition and configuration.	√					√
5.1.4	For rotorcraft: Ground Resonance model (if applicable to the simulated aircraft) that is characteristic of the simulated aircraft type to include, but not limited to, the effect of the flight controls position, the rotorcraft weight and balance, the main rotor speed, and the stiffness of the undercarriage.		√	√			√
5.2	GROUND MOVEMENT CHARACTERISTICS The ground movement characteristics - during taxi, take-off and landing movement - include the behaviour of contact between the ground and aircraft elements (e.g. brakes, turning radius, rate of turn) and the elements of atmosphere that may be encountered in ground operations (e.g. crosswinds).						
5.2.1	The handling characteristics, effect of control inputs, to include braking, deceleration and turning radius shall replicate the simulated aircraft type and variant.			√	1.a	1.b	√
5.2.2	The handling characteristics, effect of control inputs, to include braking, deceleration and turning radius shall be characteristic of the simulated aircraft type.		√		1.a	1.b	√
5.2.3	The handling characteristics and effect of control inputs shall be characteristic of the simulated aircraft class or group.	√					√

5: PERFORMANCE AND HANDLING ON GROUND (GND)								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
5.2.4	The effect of control inputs to counteract atmospheric effects (to include crosswind where applicable), shall replicate the simulated aircraft type and variant.			√	1.b 2.e	1.b 1.j	√
5.2.5	The effect of control inputs to counteract atmospheric effects (to include crosswind where applicable), shall be characteristic of the simulated aircraft type.		√		1.b 2.e	1.b 1.j	√
5.2.6	The effect of control inputs to counteract atmospheric effects shall be characteristic of the simulated aircraft class or group.	√			1.b 2.e	1.b 1.j	√
5.3	SURFACE AND OPERATING SITE CONDITIONS Aircraft performance on ground for nominal or contaminated conditions on ground or particular infrastructure, (wet, icy etc.).						
5.3.1	Stopping and directional performance and handling characteristics for at least the following landing and take-off surface conditions based on aircraft related data for a landing or running landing, which replicates the simulated aircraft type and variant (where appropriate for the aircraft area of operations and aircraft configuration). (1) dry; (2) wet (for rotorcraft: soft and hard surface); (3) icy; (4) patchy wet; (5) patchy ice; (6) wet on rubber residue in touchdown zone (for aeroplane); and (7) slope landings (for rotorcraft).			√	1.e		√

5: PERFORMANCE AND HANDLING ON GROUND (GND)								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
5.3.2	Stopping and directional performance and handling characteristics shall be characteristic of the simulated aircraft type for at least the following landing surface conditions based on aircraft related data for a landing or running landing: (where appropriate for the aircraft area of operations and aircraft configuration) (1) dry; and (2) wet		√		1.e		√
5.3.3	Stopping and directional performance and handling characteristics for dry landing surface conditions for a landing or running landing (if appropriate for the aircraft area of operations and aircraft configuration) shall be characteristic of the simulated aircraft class or group.	√					√
5.4	BRAKE AND TYRE FAILURES						
4.1	Brake and tyre failure dynamics (including anti-skid) and decreased brake efficiency due to brake temperatures shall replicate the simulated aircraft type and variant. Stopping and directional forces shall be characteristic for all environmental landing conditions.			√			√
5.5	STRIKES						
5.5.1	The effects of aircraft striking the ground (e.g. tail strike, pod strike, wing tip strike), as a function of the aircraft geometry, shall be simulated.		√	√			
5.6	AERODYNAMICS						
5.6.1	An aerodynamics and flight dynamics model that includes ground effects shall replicate the simulated aircraft type and variant.			√			√
5.6.2	Ground reaction and aerodynamic modelling for the effects of crosswind, sideslip, on directional control.			√	1.a, 1.b, 2.e	1.b, 1.j	√

5: PERFORMANCE AND HANDLING ON GROUND (GND)							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
5.6.3	For aeroplanes: Aerodynamic modelling, that includes normal and reverse dynamic thrust effect on control surfaces, aeroelastic effect and representations on non-linearities due to sideslip shall replicate the simulated aircraft type and variant.			✓	1.a, 1.b, 2.e		✓
5.6.4	For aeroplanes: Aerodynamic and ground reaction modelling for the effects of reverse thrust on directional control.		✓		1.a, 1.b, 2.e		✓
5.6.5	An acceptable simulation of ground effect includes modelling of lift/thrust, airframe drag, pitching moment, trim and power while on ground. This shall include the effects on lateral-directional characteristics, such as roll damping.			✓	1.a, 1.b, 2.e	1.b, 1.j	✓
5.6.6	Aerodynamics, flight dynamics and lift/thrust system modelling, characteristic of the simulated aircraft type, on the ground.		✓		1.a, 1.b, 2.e	1.b, 1.j	✓
5.6.7	Aerodynamics, flight dynamics and lift/thrust system modelling, characteristic of the simulated aircraft class or group, on the ground.	✓			1.b, 2.e	1.b, 1.j	✓
5.7	GROUND DYNAMICS AND HANDLING						
5.7.1	The performance and handling shall replicate simulated aircraft type and variant during the on-ground segment of take-off and landing.			✓			✓
5.7.2	The performance and handling shall be characteristic of the simulated aircraft type during the on-ground segment of take-off and landing.		✓				✓
5.7.3	The performance and handling shall be characteristic of the simulated aircraft class or group during the on-ground segment of take-off and landing.	✓					✓
5.8	AERODYNAMIC FLIGHT CONTROLS HANDLING RESPONSE						

5: PERFORMANCE AND HANDLING ON GROUND (GND)								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
5.8.1	The flight control input shall result in the aircraft response that replicates the simulated aircraft type and variant.			√	1.a, 1.b, 1.e, 2.e	1.b, 1.j	√
5.8.2	The flight control input shall result in the aircraft response that is characteristic of the simulated aircraft type.		√		1.a, 1.b, 1.e, 2.e	1.b, 1.j	√
5.8.3	The flight control input shall result in the aircraft response that is characteristic of the simulated aircraft class or group.	√			1.b, 1.e, 2.e	1.b, 1.j	√
5.9	ICING EFFECTS						
5.9.1	Flight model that includes the effects of icing, if applicable, on the airframe, the lift/thrust system aerodynamics and the engine(s). Refer to CS FSTD.QB.107.1.ICING.			√			√
5.9.2	For aeroplanes: Icing models shall simulate the aerodynamic degradation effects of ice accretion on the lift/thrust system lifting surfaces, including loss of efficiency, effect on power setting, change in pitching, rolling moments, decrease in control effectiveness, and changes in control forces in addition to any overall increase in drag or aircraft fuselage gross mass with resulting effects on power.			√			√
5.9.3	For rotorcraft: Icing model shall simulate the aerodynamic degradation effects of airframe and rotor icing (if applicable).			√			√
5.10	ENGINE PERFORMANCE						
5.10.1	The engine performance shall replicate the simulated aircraft.			√			√
5.10.2	The engine performance shall be characteristic of the simulated aircraft type.		√				√
5.10.3	The engine performance shall be characteristic of the simulated aircraft class or group.	√					√

5: PERFORMANCE AND HANDLING ON GROUND (GND)							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
5.11	PERFORMANCE AND HANDLING TRANSITION						
5.11.1	The transition between flight regimes GND and IGE shall be smooth.	✓	✓	✓			✓

GM1 CS FSTD.QB.105 FSTD general requirements for Performance And Handling On Ground (GND)

Summaries of the fidelity levels for the Performance And Handling On Ground feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.105.

5: PERFORMANCE AND HANDLING ON GROUND
Specific: The aircraft's reaction upon ground contact and its aerodynamics and lift/thrust system while on the ground replicate the behaviour of the actual aircraft. The handling characteristics and effect of control inputs (e.g. braking, deceleration, and turning radius) replicate those of the simulated aircraft type and variant. Crosswind effects, brake and tire failures, and various runway contaminants are simulated realistically.
Representative: The aircraft's reaction upon ground contact and its aerodynamics and lift/thrust system while on the ground are characteristic of the simulated aircraft type. The handling characteristics and effect of control inputs (e.g. braking, deceleration, and turning radius) are characteristic of the simulated aircraft type. Dry and wet runways are simulated.
Generic: The aircraft's reaction upon ground contact and its aerodynamics and lift/thrust system while on the ground are characteristic of the simulated aircraft class or group. The handling characteristics and effect of control inputs (e.g. braking, deceleration, and turning radius) are similarly generic and characteristic of the simulated aircraft class or group.

PERFORMANCE AND HANDLING IN GROUND EFFECT (IGE)

CS FSTD.QB.106 FSTD general requirements for Performance And Handling In Ground Effect (IGE)

6: PERFORMANCE AND HANDLING IN GROUND EFFECT (IGE)
Defines the mathematical models and associated data to be used to describe the aerodynamic, flight dynamics and lift/thrust characteristics required to be modelled in the FSTD in ground effect. The height of ground effect is the wing span, or main rotor diameter, unless otherwise declared by the OEM or data provider (as applicable).

The general requirements for the Performance and Handling In Ground Effect feature are presented in the table below.

6: PERFORMANCE AND HANDLING IN GROUND EFFECT (IGE)								
FEATURE GENERAL REQUIREMENTS		FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
6.1	GROUND EFFECT						
6.1.1	Aerodynamics and lift/thrust system modelling shall replicate the simulated aircraft type and variant in ground effect.			✓	1.b, 2.e, 2.f	1.c, 1.j	✓
6.1.2	An acceptable simulation of ground effect includes modelling of lift/thrust system efficiency, airframe drag, pitching moment, trim and power/thrust while in ground effect, and transition effect from IGE to OGE conditions and vice-versa. This shall include the effects on the lateral-directional characteristics from ground effect, such as roll damping.			✓			✓
6.1.3	Aerodynamics and lift/thrust system modelling shall be characteristic of the simulated aircraft type in ground effect.		✓		1.b, 2.e, 2.f	1.c, 1.j	✓

6.1.4	Aerodynamics and lift/thrust system modelling, characteristic of the simulated aircraft class or group in ground effect to permit ground-air transitions.	√			1.b, 2.e	1.c, 1.j	√
6.2	GROUND EFFECT DYNAMICS AND HANDLING						
6.2.1	The performance and handling characteristics during take-off, final approach and landing shall replicate the simulated aircraft type and variant. This shall include the transition to/from ground effect.			√	1.b, 2.e, 2.f	1.c, 1.j	√
6.2.2	For aeroplanes: Aerodynamic modelling, that includes normal thrust effect on control surfaces, aeroelastic effect and representations on non-linearities due to sideslip based on aeroplane flight test data provided by the data provider.			√	1.b, 2.e, 2.f		√
6.2.3	The performance and handling characteristics during take-off, final approach and landing shall be characteristic of the simulated aircraft type. This shall include the transition to/from ground effect.		√		1.b, 2.e, 2.f	1.c, 1.j	√
6.2.4	The performance and handling characteristics during take-off, final approach and landing shall be characteristic of the simulated aircraft class or group. This shall include the transition to/from ground effect.	√			1.b, 2.e	1.c, 1.j	√
6.2.5	The flight dynamic responses and stability in ground effect in ground effect shall replicate the simulated aircraft type and variant.			√	2.f	2.b, 1.j	√
6.2.6	The flight dynamic responses and stability in ground effect shall be characteristic of the simulated aircraft type.		√		2.f	2.b	√
6.2.7	The flight dynamic responses and stability in ground effect shall be characteristic of the simulated aircraft class or group.	√				2.b	√
6.2.8	For rotorcraft: The performance and handling characteristics in hover in IGE and through translational lift shall replicate the simulated aircraft type and variant.			√		1.d, 2.b	√
6.2.9	For rotorcraft: The performance and handling characteristics in hover in IGE and through translational lift shall be characteristic of the simulated aircraft type.		√			1.d, 2.b	√

6.2.10	For rotorcraft: The performance and handling characteristics in hover in IGE and through translational lift shall be characteristic of the simulated aircraft class or group.	✓				1.d, 2.b	✓
6.3	AERODYNAMIC FLIGHT CONTROLS HANDLING RESPONSE						
6.3.1	The flight control input shall result in the aircraft response that replicates the simulated aircraft type and variant.			✓	1.b-1.f, 2.c-2.h	1.e-1.h	✓
6.3.2	The flight control input shall result in the aircraft response that is characteristic of the simulated aircraft type.		✓		1.b-1.f, 2.c-2.h	1.e-1.h	✓
6.3.3	The flight control input shall result in the aircraft response that is characteristic of the simulated aircraft class or group.	✓			1.b-1.f, 2.c-2.e	1.e-1.h	✓
6.4	ATMOSPHERIC EFFECTS						
6.4.1	For aeroplane FSTDs simulating an aircraft certified under CS-25: The performance and handling characteristics during windshear effects shall replicate the simulated aircraft type and variant. Simulation of windhear is required if applicable for the FCS and simulated aircraft.			✓	2.g		✓
6.4.2	For aeroplane FSTDs simulating an aircraft certified under CS-25: The performance and handling characteristics during windshear effects shall be characteristic of the simulated aircraft type.		✓		2.g		✓
6.4.3	For rotorcraft: The performance and handling characteristics shall include the effect of atmospheric models (such as models of local wind patterns around mountains, structures and other obstacles), replicating the effect on the simulated aircraft type and variant.			✓			✓
6.5	ICING EFFECTS						
6.5.1	Flight model that includes the effects of icing, if applicable, on the airframe, the lift/thrust system aerodynamics and the engine(s). Refer to CS FSTD.QB.107.1.ICING.			✓			✓

6.5.2	For aeroplanes: Icing models shall simulate the aerodynamic degradation effects of ice accretion on the lift/thrust system lifting surfaces, including loss of efficiency, effect on power setting, change in pitching, rolling moments, decrease in control effectiveness, and changes in control forces in addition to any overall increase in drag or aircraft fuselage gross mass with resulting effects on power.			✓			✓
6.5.3	For rotorcraft: Icing model shall simulate the aerodynamic degradation effects of airframe and rotor icing (if applicable).			✓			✓
6.6	ENGINE PERFORMANCE						
6.6.1	The engine performance shall replicate the simulated aircraft.			✓			✓
6.6.2	The engine performance shall be characteristic of the simulated aircraft type.		✓				✓
6.6.3	The engine performance shall be characteristic of the simulated aircraft class or group.	✓					✓
6.7	PERFORMANCE AND HANDLING TRANSITION						
6.7.1	The transition between the flight regimes GND and IGE, and IGE and OGE shall be smooth.	✓	✓	✓			✓

GM1 CS FSTD.QB.106 FSTD general requirements for Performance And Handling In Ground Effect

Summaries of the fidelity levels for the Performance And Handling In Ground Effect feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.106.

6: PERFORMANCE AND HANDLING IN GROUND EFFECT
Specific: Aerodynamic, lift/thrust system and any other relevant modelling close to the ground or in ground effect, that is replicating the particular aircraft type and variant. This includes the effects of change in aircraft attitude, airspeed, thrust and other applicable variables.
Representative: Aerodynamic and lift/thrust system modelling close to the ground or in ground effect, that is characteristic of an aircraft type. This includes the effects of change in aircraft attitude, airspeed, thrust and other applicable variables.
Generic: Aerodynamic and lift/thrust system modelling close to the ground or in ground, that is characteristic of the simulated aircraft class or group. This includes the effects of change in aircraft attitude, airspeed, thrust and other applicable variables.

PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)

CS FSTD.QB.107 FSTD general requirements for Performance And Handling Out Of Ground Effect (OGE)

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)
Defines the mathematical models and associated data to be used to describe the aerodynamics, flight dynamics and lift/thrust system characteristics required to be modelled in the FSTD away from the ground and out of ground effect.

The general requirements for the Performance And Handling Out Of Ground Effect feature are presented in the table below.

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)								
FEATURE GENERAL REQUIREMENTS		FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
7.1	FLIGHT DYNAMICS MODEL						
7.1.1	A flight dynamics model that replicates the simulated aircraft type and variant, including aerodynamic and lift/thrust system modelling, that accounts for all combinations of drag and thrust, of airspeed and power normally encountered in flight including the effect of change in aircraft attitude, aerodynamic forces and moments and forces and moments of rotors, aerodynamic interference, altitude, temperature, mass, centre of gravity location and configuration.			✓	1.b-1.f, 2.c-2.h	1.e-1.h	✓
7.1.2	A flight dynamics model that is characteristic of the simulated aircraft type, including aerodynamic and lift/thrust system modelling, that accounts for various combinations of drag and thrust normally encountered in flight including the effect of change in aircraft attitude, aerodynamic forces and moments and forces and moments of rotors, altitude, temperature, mass, centre of gravity location and configuration.		✓		1.b-1.f, 2.c-2.h	1.e-1.h	✓

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)								
FEATURE GENERAL REQUIREMENTS		FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
7.1.3	A flight dynamics model that is characteristic of the simulated aircraft class or group, including aerodynamic and lift/thrust system modelling, that accounts for various combinations of drag and thrust normally encountered in flight including the effect of change in aircraft attitude, altitude, temperature, mass, centre of gravity location and configuration.	✓			1.b-1.f, 2.c-2.e	1.e-1.h	✓
7.1.4	For aeroplanes: Aerodynamic modelling, that includes Mach effect, normal dynamic thrust effect on control surfaces, aeroelastic effect and representations on non-linearities due to sideslip based on aeroplane flight test data provided by the data provider.			✓	1.b-1.f, 2.c-2.h	1.e-1.h	✓
7.1.5	For rotorcraft: The performance and handling characteristics in hover in OGE and through translational lift and transition to forward flight shall replicate the simulated aircraft type and variant.			✓		1.d, 2.b	✓
7.1.6	For rotorcraft: The performance and handling characteristics in hover in OGE and through translational lift and transition to forward flight shall be characteristic of the simulated aircraft type.		✓			1.d, 2.b	✓
7.1.7	For rotorcraft: The performance and handling characteristics in hover in OGE and through translational lift and transition to forward flight shall be characteristic of the simulated aircraft class or group.	✓				1.d, 2.b	✓
7.1.8	The flight dynamics model for the performance and handling shall replicate the simulated aircraft type and variant. This shall include the effect of change in parameters for attitude, sideslip, thrust, drag, altitude, temperature, gross weight, moments of inertia, centre of gravity location and configuration.			✓	1.b-1.f, 2.c-2.h	1.e-1.h	✓
7.1.9	The flight dynamics model for the performance and handling shall be characteristic of the simulated aircraft type. This shall include the effect of change in parameters for attitude, sideslip, thrust, drag, altitude, temperature, gross weight, moments of inertia, centre of gravity location and configuration.		✓		1.b-1.f, 2.c-2.h	1.e-1.h	✓

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)								
FEATURE GENERAL REQUIREMENTS		FIDELITY LEVEL			VERIFICATION & VALIDATION			
		G	R	S	QTG(A)	QTG(H)	F&S	
7.1.10	The flight dynamics model for the performance and handling shall be characteristic of the simulated aircraft class or group. This shall include the effect of change in parameters for attitude, sideslip, thrust, drag, altitude, temperature, gross weight, moments of inertia, centre of gravity location and configuration.	√			1.b-1.f, 2.c-2.e	1.e-1.h	√	
7.1.11	The engine performance shall replicate the simulated aircraft.			√	1.f	1.a	√	
7.1.12	The engine performance shall be characteristic of the simulated aircraft type.		√		1.f	1.a	√	
7.1.13	The engine performance shall be characteristic of the simulated aircraft class or group.	√			1.f	1.a	√	
7.1.14	The aircraft dynamic handling and stability characteristics shall replicate the simulated aircraft type and variant.			√	2.c, 2.d	2.c, 2.d	√	
7.1.15	The aircraft dynamic handling and stability characteristics shall be characteristic of the simulated aircraft type.		√		2.c, 2.d	2.c, 2.d	√	
7.1.16	The aircraft dynamic handling and stability characteristics shall be characteristic of the simulated aircraft class or group.	√			2.c, 2.d	2.c, 2.d	√	
7.1.17	The flight dynamics model for the performance and handling during approach shall replicate the simulated aircraft type and variant. This shall include the transition into ground effect.			√	2.e	1.j	√	
7.1.18	The flight dynamics model for the performance and handling during approach shall be characteristic of the simulated aircraft type. This shall include the transition into ground effect.		√		2.e	1.j	√	
7.1.19	The flight dynamics model for the performance and handling during approach shall be characteristic of the simulated aircraft class or group. This shall include the transition into ground effect.	√			2.e	1.j	√	
7.1.20	The performance and handling characteristics during climb, level flight and descent shall replicate the simulated aircraft type and variant.			√	1.c, 1.d, 2.c, 2.d	1.e, 1.f, 1.h, 1.j	√	

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)								
FEATURE GENERAL REQUIREMENTS		FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
7.1.21	The performance and handling characteristics during climb, level flight and descent shall be characteristic of the simulated aircraft type.		✓		1.c, 1.d, 2.c, 2.d	1.e, 1.f, 1.h, 1.j	✓
7.1.22	The performance and handling characteristics during climb, level flight and descent shall be characteristic of the simulated aircraft class or group.	✓			1.c, 1.d, 2.c, 2.d	1.e, 1.f, 1.h, 1.j	✓
7.1.23	The Mach effects in the aerodynamic model shall replicate the simulated aircraft type and variant as applicable.			✓			✓
7.1.24	The Mach effects in the aerodynamic model shall be characteristic to the simulated aircraft type as applicable.		✓				✓
7.1.25	The Mach effects in the aerodynamic model shall be characteristic to the simulated aircraft class or group as applicable.	✓					✓
7.1.26	The aerodynamic model shall replicate the aeroelastic effects.			✓			✓
7.2	ICING EFFECTS Defines the effects of icing on the aircraft - e.g. the airframe, the lift/thrust system, aerodynamics, flight dynamics, surfaces, engines as applicable.						
7.2.1	Flight model that includes the effects of icing, if applicable, on the airframe, the lift/thrust system aerodynamics and the engine(s).			✓	2.i		✓

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)								
FEATURE GENERAL REQUIREMENTS		FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
7.2.2	For aeroplanes: Icing models shall simulate the aerodynamic degradation effects of ice accretion on the lift/thrust system lifting surfaces, including loss of efficiency, effect on power setting, change in pitching, rolling moments, decrease in control effectiveness and changes in control forces in addition to any overall increase in drag or aircraft fuselage gross mass with resulting effects on power. Aeroplane original equipment manufacturer (OEM) data or other acceptable analytical methods must be used to develop ice accretion models. Acceptable methods may include wind tunnel analysis 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 (SME) pilot knowledgeable of the effect of ice accretion on the handling qualities of the simulated aeroplane. The Statement of Justification shall describe the effects that provide training in the specific skills for recognition of icing phenomena and execution of recovery. The SOJ shall describe the source data and any analytical methods used to develop ice accretion models, including a verification that these effects have been tested. Refer to CS FSTD.QB.107.1.ICING.			✓	2.i		✓
7.2.3	For rotorcraft: Icing model shall simulate the aerodynamic degradation effects of airframe and rotor icing, and performance degradations due to icing (if applicable).			✓			✓
7.2.4	Modelling that includes the effects of icing, where appropriate, on the airframe, aerodynamics and the engine(s). Icing models with performance degradations due to icing shall be provided.	✓	✓				✓
7.3	SPECIAL EFFECTS FOR ROTORCRAFT Defines the aerodynamic special effects that are applicable to rotorcraft, such as vortex ring and retreating blade stall.						

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)							
FEATURE GENERAL REQUIREMENTS		**FIDELITY LEVEL**			**VERIFICATION & VALIDATION**		
		G	**R**	**S**	**QTG(A)**	**QTG(H)**	**F&S**
7.3.1	Flight model that includes the effects of interference between the rotor wake and fuselage, influence of the rotor on control and stabilisation systems, and representations of non-linearities due to sideslip, vortex ring (settling with power) and retreating blade stall.			√			√
7.3.2	Flight model that includes (as applicable to aircraft type and variant) the effects of the following: (1) aerodynamic interference effects between the rotor wake and fuselage (2) influence of the rotor on control and stabilisation systems (3) representations of non-linearities due to sideslip (4) vortex ring (settling with power) and retreating blade stall (5) aeroelastic effects (6) Mach effects on rotors (7) unexpected yaw / loss of tail rotor effectiveness (LTE)			√			√
7.3.3	Flight model that includes (as applicable to aircraft type) the effects of the following: (1) aerodynamic interference effects between the rotor wake and fuselage (2) influence of the rotor on control and stabilisation systems (3) representations of non-linearities due to sideslip (4) vortex ring (settling with power) and retreating blade stall (5) unexpected yaw / loss of tail rotor effectiveness (LTE)		√				√
7.3.4	Flight model that includes (as applicable to the simulated aircraft class or group) the effects of the following: (1) aerodynamic interference effects between the rotor wake and fuselage (2) influence of the rotor on control and stabilisation systems (3) representations of non-linearities due to sideslip.	√					√

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)							
FEATURE GENERAL REQUIREMENTS		**FIDELITY LEVEL**			**VERIFICATION & VALIDATION**		
		G	**R**	**S**	**QTG(A)**	**QTG(H)**	**F&S**
7.3.5	The performance and handling characteristics in hover shall replicate the simulated aircraft type and variant.			√		1.d	√
7.3.6	The performance and handling characteristics in hover shall be characteristic of the simulated aircraft type.		√				√
7.3.7	The performance and handling characteristics in hover shall be characteristic of the simulated aircraft class or group.	√					√
7.4	SPECIAL EFFECTS FOR AEROPLANES These requirements apply only to FSTDs that are to be qualified to conduct upset prevention and recovery training (UPRT).						
7.4.1	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.			√			√
7.4.2	The aerodynamic modelling has to support UPRT tasks in the following upset recovery manoeuvres: (1) a nose-high wings level aeroplane upset; (2) a nose-low aeroplane upset; and (3) a high bank angle aeroplane upset. Other upset prevention and recovery scenarios may be developed by the organisation requesting qualification of an FSTD. All the upset prevention and recovery manoeuvres and scenarios shall be made available to the instructor. Refer to CS FSTD.QB.115, section 15.3 'Upset Prevention and Recovery Training'.			√			√

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)								
FEATURE GENERAL REQUIREMENTS		FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
7.4.3	For FSTDs that are qualified for full-stall training tasks: The aerodynamic modelling has to support stall-recovery training tasks in the following flight conditions: (1) stall entry at wings level (1g); (2) stall entry into turning flight of at least 25° bank angle (accelerated stall); (3) stall entry into a power-on condition (required only for propeller-driven aeroplanes); and (4) aeroplane configurations of second-segment climb, high-altitude cruise ('near performance-limited condition'), and approach or landing. The SOJ shall describe the aerodynamic-modelling methods, validation, and check of the stall characteristics of the FSTD, and shall include a verification that the FSTD has been evaluated by an SME pilot acceptable to the competent authority. Refer to CS FSTD.QB.107.2.STALL and CS FSTD.QB.107.3.STALL. Refer to CS FSTD.GEN.005 for a definition of the 'near performance-limited condition'.			✓	2.c.8.a		✓
7.4.4	For FSTDs not qualified to conduct full stall training tasks: The aerodynamic modelling shall support stall event training tasks in the following flight conditions: (1) approach to stall during second segment climb; (2) approach to stall at high-altitude cruise (near performance limited condition); (3) approach to stall during either approach or landing;			✓	2.c.8.b		✓
7.5	MASS PROPERTIES						

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)							
FEATURE GENERAL REQUIREMENTS		FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
7.5.1	For aeroplanes: Aircraft type specific mass properties model, including mass or weight, CoG and moments of inertia as a function of payload, fuel, or any consumable loading shall be implemented. The SOJ shall include a range of tabulated target values to enable a demonstration of the mass properties model to be conducted from the instructor’s station.			√			√
7.5.2	A representative, aircraft-like, mass properties model including mass, centre of gravity and moments of inertia as a function of payload , fuel or any consumable loading shall be implemented.		√				√
7.5.3	A generic, aircraft-like, mass properties model, including mass, centre of gravity and moments of inertia as a function of payload , fuel or any consumable loading shall be implemented.	√					√
7.6	ATMOSPHERIC EFFECTS Defines the effect of atmospheric disturbances on the performance and handling.						
7.6.1	For aeroplane FSTDs simulating an aircraft certified under CS-25: The performance and handling characteristics during windshear effects shall replicate the simulated aircraft type and variant.			√	2.g		√
7.6.2	For aeroplane FSTDs simulating an aircraft certified under CS-25: The performance and handling characteristics during windshear effects shall be characteristic of the simulated aircraft type.		√				√
7.6.3	For rotorcraft: The performance and handling characteristics shall include the effect of atmospheric models (such as models of local wind patterns around mountains, structures and other obstacles), replicating the effect on the simulated aircraft type and variant.			√			√
7.7	AERODYNAMIC FLIGHT CONTROLS HANDLING RESPONSE						

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT (OGE)							
FEATURE GENERAL REQUIREMENTS		FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
7.7.1	The flight control input shall result in the aircraft response that replicates the simulated aircraft type and variant.			√	1.b-1.d, 2.c-2.i,	1.c-1.j, 2.b-2.d	√
7.7.2	The flight control input shall result in the aircraft response that is characteristic of the simulated aircraft type.		√		1.b-1.d, 2.c-2.i,	1.c-1.j, 2.b-2.d	√
7.7.3	The flight control input shall result in the aircraft response that is characteristic of the simulated aircraft class or group.	√			1.b-1.d, 2.c-2.i,	1.c-1.j, 2.b-2.d	√
7.8	PERFORMANCE AND HANDLING TRANSITION						
7.8.1	The transition between the flight regimes IGE and OGE shall be smooth.	√	√	√			√

GM1 CS FSTD.QB.107 FSTD general requirements for Performance And Handling Out Of Ground Effect

Summaries of the fidelity levels for the Performance And Handling Out Of Ground Effect feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.107.

7: PERFORMANCE AND HANDLING OUT OF GROUND EFFECT
Specific: Aerodynamic, lift/thrust system and any other relevant modelling out of ground effect, that is replicating the particular aircraft type and variant. This includes the effect of change in aircraft attitude, aerodynamic forces and moments and forces and moments of rotors, aerodynamic interference, altitude, temperature, mass, centre of gravity location and configuration.
Representative: Aerodynamic and lift/thrust system modelling is characteristic of the simulated aircraft type according to design characteristics that affect the aerodynamic model. This includes the effect of change in aircraft attitude, aerodynamic forces and moments and forces and moments of rotors, altitude, temperature, mass, centre of gravity location and configuration.
Generic: Aerodynamic and lift/thrust system modelling is characteristic of an aircraft class or group. This includes the effect of change in aircraft attitude, altitude, temperature, mass, centre of gravity location and configuration.

GM2 CS FSTD.QB.107 Generic fidelity level of Performance And Handling Out Of Ground Effect

This GM gives guidance on Generic fidelity level of Performance And Handling Out Of Ground Effect.

As Subpart C states, data for generic performance and handling may originate also from certification specifications of real aircraft (e.g. CS-23, CS-25, CS-27 or CS-29). The requirements in the above mentioned certification specifications may require for example that the aircraft must have positive damping on dynamic stability. For generic performance and handling, it does not mean that the simulation may be too stable. Generic performance and handling still requires that the flight characteristics are similar to a real aircraft that exists within the simulated aircraft class or group. This should be demonstrated in the Engineering Report. As a summary, the real aircraft certifications specifications may not be useful alone but should be considered on a case-by-case basis and may need to be complimented by other data too. See Subpart C for more information.

As is required by CS FSTD.QB.107, the simulation should include the effects of change in various parameters. For example, it is expected that the stability of any aircraft should be lower at high altitudes than for sea level. This is caused by the air density and reduced aerodynamic damping at high altitudes. It is important to note that the aerodynamic effects are more complex for aircraft that fly at higher altitudes or at higher Mach number. Also, the effects are more complex for aircraft that have couplings, such as any helicopter, or a swept-wing aircraft. Further, the effects are affected by the aircraft systems. Any stabilisation system (e.g. SAS, autotrim, yaw damper) or computer controlled aircraft (CCA) would have an important effect on the performance and handling, associated phenomena and realism. For positive transfer of training, these effects and phenomena should be simulated and realistic even at Generic fidelity level. For the Generic Level, the Engineering Report should demonstrate that an aircraft within the simulated class or group exists with similar characteristics as the FSTD.

It should be noted that simulation of complex aircraft is complex even at the Generic fidelity level.

GM3 CS FSTD.QB.107 Engine or powerplant failure

CS FSTD.QB.105, CS FSTD.QB.106, and CS FSTD.QB.107 outline the requirements for performance and handling, including which parameter changes must be accounted for. Thrust and drag are among those parameters. They address any changes in engine or powerplant parameters or failure of the engine or powerplant. This means that the failure effects (e.g. loss of thrust, increase in drag) must be accounted for and must result in consequent changes in other parameters (e.g. dynamics, changes in performance, attitude, sideslip, airspeed, necessary flight control inputs, and trimming, etc.).

CS FSTD.QB.107.1.ICING FSTD requirements for engine and airframe icing

This CS defines requirements for engine and airframe icing.

This CS applies to all FSTDs that are used to satisfy training provisions for engine and airframe icing.

(a) General provisions

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

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

(2) icing models shall 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 shall be objectively tested to demonstrate that it has been implemented correctly and that it generates the correct cues as necessary for training.

(b) Statement of Justification (SOJ)

The SOJ required in CS FSTD.QB.107 row 7.2.2 shall 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 shall 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 shall 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.

CS FSTD.QB.107.2.STALL FSTD requirements for stall modelling

This CS provides standards related to stall modelling.

This CS applies only to FSTDs that are to be qualified to conduct full-stall training tasks.

(a) Angle of attack and sideslip range of the aerodynamics model:

(1) for continuity purposes, the model shall remain useable beyond the FSTD training envelope to the extent that it allows completion of the recovery training; and

(2) 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 shall be declared in the required SOJ and in the ESL.

(b) Characteristics of stall modelling:

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

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

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

(4) apparent randomness or non-repeatability;

(5) changes in pitch stability;

(6) Mach effects; and

(7) stall buffet, as appropriate to the aeroplane type;

(8) the model shall 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);

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

(10) specific guidance shall 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

(11) FSTDs that are to be qualified for full-stall training tasks shall also meet the IOS provisions for upset prevention and recovery training (UPRT) tasks as described in CS FSTD.QB.115.

CS FSTD.QB.107.3.STALL FSTD requirements for stall manoeuvres

This CS provides standards related to the justification of the high angle of attack and stall modelling:

This CS 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 CS 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.

(a) General provisions.

The provisions for high angle of attack modelling shall 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 Subpart D 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 SOJ shall define the source data and methods used to develop the aerodynamic stall model.

(b) Fidelity provisions

The provisions for the evaluation of full-stall training manoeuvres shall 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 ‘characteristic’ of the aeroplane being simulated to allow successful completion of the stall recovery training tasks.

For the purposes of stall manoeuvre evaluation, the term ‘characteristic’ is defined as a level of fidelity that is type-specific for the simulated aeroplane to the extent that the training objectives can be satisfactorily accomplished. Therefore, the term ‘characteristic’ in this CS is specifically limited to the elements of the aerodynamic model in the post-stall region.

(c) Statement of Justification (aerodynamic model)

At a minimum, the following shall be addressed in the SOJ:

(1) Source data and modelling methods

The SOJ shall 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 shall 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 organisation requesting qualification of an FSTD shall declare the range of angle of attack and sideslip where the aerodynamic model remains valid for training. Satisfactory aerodynamic model fidelity shall 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 2 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 shall allow for an angle of attack range that is adequate to allow for the completion of stall recovery; for pusher-equipped aeroplanes, this shall be adequate to capture any inappropriate action during the recovery procedure.

For aeroplanes equipped with a stall envelope protection system, the model shall 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 SOJ shall address, and the aerodynamic model shall incorporate, the following stall characteristics, where applicable by aeroplane type:

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

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

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

(4) apparent randomness or non-repeatability;

(5) changes in pitch stability;

(6) stall hysteresis;

(7) Mach effects;

(8) stall buffet; and

(9) angle of attack rate effects.

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

(d) Statement of Justification (SOJ) (subject matter expert (SME) pilot's evaluation)

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

The operator is also required to provide an SOJ 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 shall 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 shall 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 shall 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 SOJ 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 SOJ 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 (refer to CS FSTD.GEN.015 Terminology and CS FSTD.ENG.040 for the requirements on an engineering simulator).

In the context of this subpart, a 'Development simulator' means a data provider's simulator, which serves as a platform for the development of alternative engineering simulation data and models. This could be based on a specific aeroplane or a representation of its type. It would typically operate in real time and if necessary, can be flown by a pilot to subjectively evaluate the simulation.

The organisation requesting qualification of an FSTD 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 shall include the following information:

(1) an assessment of pilot availability demonstrating that an SME pilot, meeting the experience described in this CS, 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.

(e) Statement of Justification (SOJ) (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 shall be applied in the same way during the simulator's subjective evaluation.

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

The increase in angle of attack beyond the validity range CL max shall be limited to a value not greater than the maximum angle achieved 2 seconds after stall recognition, which is sufficient to allow a proper recovery manoeuvre.

Stall recognition is defined by the occurrence of one or more of the following effects, as applicable to the simulated aeroplane type:

(1) no further increase in pitch occurs when the pitch control is held at the full aft stop for 2 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 shall be declared in the required SOJ.

SOUND CUEING (SND)

CS FSTD.QB.108 FSTD general requirements for Sound Cueing (SND)

8: SOUND CUES
Defines the type of sound cues to be modelled. Such sound cues are those related to sounds generated externally to the flight deck environment such as sounds of aerodynamics, propulsion, rotor noises, operating site elements (e.g. runway rumble) weather effects. Note: Sounds generated by the aircraft systems for pilots to observe (e.g. communications systems, system and avionics audio tones, messages, cautions, warnings or any sound for indication purposes) are covered separately in the 'Aircraft Systems' feature in CS FSTD.QB.104. Note: The words 'aircraft systems' below refer to components generating sounds audible to the flight crew, such as pumps, motors, fans, vents, air flow and wipers.

The general requirements for the Sound Cueing feature are presented in the table below.

8: SOUND CUES						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
8.1	SOUND SYSTEM					
8.1.1	Significant sounds perceptible to the flight crew during flight operations shall replicate the simulated aircraft type and variant.			✓		✓
8.1.2	Significant sounds perceptible to the flight crew during flight operations shall be characteristic of the simulated aircraft type.		✓			✓

8: SOUND CUES						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
8.1.3	Significant sounds perceptible to the flight crew during flight operations shall be characteristic to the simulated aircraft class or group, including basic engine, propeller, rotor, airframe and aircraft systems sounds.	✓				✓
8.2	SOUND CONTENTS AND QUALITIES					
8.2.1	Sound frequencies and amplitudes shall replicate the simulated aircraft type and variant. Sounds shall include engine, propeller, transmission, rotor, airframe, aircraft systems and environmental sounds as well as those generated by pilot or instructor actions. Sounds shall be a function of flight conditions. For example, variable IAS, aircraft configuration, variable engine noise, rotor speed, blade slap, etc., as appropriate to the aircraft. Sounds shall correlate with aircraft systems simulation and motion/vibration platform (when installed).			✓	5.a, 5.b, 5.c	✓
8.2.2	The background noise level of the FSTD shall be below set tolerances.	✓	✓	✓	5.d	✓
8.2.3	The frequency response of the speakers shall be within set tolerances.		✓	✓	5.e	
8.2.4	Sounds shall include engine, propeller, transmission, rotor, airframe, aircraft systems and environmental sounds as well as those generated by pilot or instructor actions. Sounds shall be a function of flight conditions. For example, variable IAS, aircraft configuration, variable engine noise, rotor speed, blade slap, etc., as appropriate to the aircraft. Sounds shall correlate with aircraft systems simulation and motion/vibration platform (when installed).		✓		5.a, 5.b, 5.c	✓

8: SOUND CUES						
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**	
		G	**R**	**S**	**QTG**	**F&S**
8.2.5	Sounds shall include engine, rotor and aircraft systems sounds as well as those generated by pilot or instructor actions. Sounds shall be a function of flight conditions. For example, variable IAS, aircraft configuration, variable engine noise, rotor speed, blade slap, etc., as appropriate to the aircraft.	√			5.a, 5.b, 5.c	√
8.3	CRASH AND STRIKE SOUNDS					
8.3.1	Sounds shall include a sound effect for a crash when the simulated aircraft exceeds limitations such as but not limited to structural or flight envelope exceedances.	√	√	√		√
8.3.2	Sounds shall include a sound effect for a crash when impacting with ground structures or another aircraft.	√	√	√		√
8.3.3	Sounds shall include sound effects for aircraft striking the ground (e.g. tail strike, pod strike, wing tip strike).			√		√
8.4	ENVIRONMENTAL SOUNDS					
8.4.1	Significant environmental sounds shall be consistent with the simulated weather.		√	√		√
8.4.2	Environmental sounds are not required. If present, they shall be consistent with the simulated weather.	√				
8.5	SOUND VOLUME					
8.5.1	If the instructor operating station (IOS) has a volume control, the following applies: Full volume shall correspond to actual volume levels in the validation data meeting all the qualification requirements. When full volume is not selected, the IOS shall have an indication which is visible at all the times.			√		√

8: SOUND CUES						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
8.5.2	If the instructor operating station (IOS) has a volume control, the following applies: Full volume shall correspond to the volume level agreed as part of the initial qualification. When full volume is not selected, the IOS shall have an indication which is visible at all the times.	✓	✓			✓
8.6	SOUND DIRECTIONALITY					
8.6.1	Sounds shall be directionally replicating the simulated aircraft type and variant. Although most steady state sounds originate above and behind, specific sounds which are directional (e.g. skids impact during an asymmetric touchdown, windshield wipers) shall be directionally differentiated.			✓		✓
8.6.2	Sounds shall be directionally characteristic of the simulated aircraft type.		✓			✓
8.6.3	Engine, propeller and rotor sounds shall be directionally characteristic if they are asymmetric for the simulated aircraft class or group for normal, abnormal or emergency situations (e.g. multi-engine aeroplane with wing-mounted engines is expected to have asymmetric engine sounds when only one engine is operating). Other than that, the sounds are not required to be directional.	✓				✓

GM1 CS FSTD.QB.108 FSTD general requirements for Sound Cueing

Summaries of the fidelity levels for the Sound Cueing feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.108.

8: SOUND CUEING
Specific: Directional sounds include engine, propeller, transmission, rotor, airframe, aircraft systems and environmental sounds as well as those generated by pilot or instructor actions. Sounds are a function of flight conditions. Significant environmental sounds are consistent with the simulated weather. Sound frequencies and amplitudes replicate the simulated aircraft type and variant.
Representative: Directional sounds include engine, propeller, transmission, rotor, airframe, aircraft systems and environmental sounds as well as those generated by pilot or instructor actions. Sounds are a function of flight conditions. Significant environmental sounds are consistent with the simulated weather.
Generic: Significant sounds include engine, rotor and aircraft systems sounds as well as those generated by pilot or instructor actions. Environmental sounds are not required.

GM2 CS FSTD.QB.108 FSTD general requirements for Sound Cueing

The Sound Cueing feature covers the aircraft sounds such as those external to the flight deck environment - the engine sounds, aerodynamic sounds that are intended to replicate the sound environment in the aircraft flight deck. This also includes the sounds that are simulation effects, such as those related to the weather. The sound effects, such as crash sounds, are artificial sounds to provide a cue to the pilots.

It is recognised that the sound cues for the Specific fidelity level may not necessarily be a perfect replication of the simulated type and variant, but will be validated objectively against aircraft type data in addition to the subjective validation.

VIBRATION CUEING (VIB)

CS FSTD.QB.109 FSTD general requirements for Vibration Cueing (VIB)

9: VIBRATION CUEING
Defines the vibrations and buffets to be modelled in the FSTD that may be felt by the pilots during all phases of flight from effects such as airframe buffet, control surface buffet, engine and propeller or rotor and transmission vibrations, systems operation, weather, and ground operations. These vibrations may vary significantly depending on the flight parameters, for example, rotorcraft hover in or out of ground effect, hover into wind, downwind hover, hover taxi, transition to forward flight, translational lift, cruise, turns, steep turns, autorotation and so on, where relevant to the aircraft type. Note: This feature does not contain the motion effects (e.g. touchdown cues of the landing gear). See ‘Motion Cueing’ feature in CS FSTD.QB.110 for their requirements. Note: See definitions of ‘vibration’ and ‘buffet’ in CS FSTD.GEN.015.

The general requirements for the Vibration Cueing feature are presented in the table below.

9: VIBRATION CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
9.1	VIBRATION CUES GENERAL					
9.1.1	Vibrations and buffets that result from operation of the aircraft which can be sensed in the flight deck shall replicate the simulated aircraft type and variant in so far as the vibration or buffet marks an event or aircraft state that can be sensed in the flight deck.			✓	3.g	✓
9.1.2	Vibrations and buffets that result from operation of the aircraft which can be sensed in the flight deck shall be characteristic of the simulated aircraft type in so far as the vibration or buffet marks an event or aircraft state that can be sensed in the flight deck.		✓		3.g	✓

9: VIBRATION CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
9.1.3	Vibrations and buffets that result from operation of the aircraft which can be sensed in the flight deck shall be characteristic of the simulated aircraft class or group in so far as the vibration or buffet marks an event or aircraft state that can be sensed in the flight deck.	√				√
9.1	VIBRATION CUES FOR ROTORCRAFT (AS APPLICABLE)					
9.2.1	Vibration cue fidelity to incorporate all those provided by R fidelity in 9.2.2 but specific to aircraft type and variant, plus additional cues emanating from landing gear state, main rotor and tail rotor torque loading effects, and detailed malfunction effects (to include those associated with main rotor damper, vibration suppression systems, and anti-torque bearing/coupling/gearbox/driveshaft).			√	3.g	√
9.2.2	Vibration cue fidelity to incorporate all those provided by G fidelity in 9.2.3, plus additional primary anti-torque system vibration cues (e.g. tail rotor, fenestron, NOTAR system), cues due to main rotor and anti-torque system blade tracking and balance effects, hydraulic system failures, icing effects, vortex ring (settling with power) state, autorotation and basic anti-torque system failure cues. Cues due to operation in the low relative speed environment (e.g. relative wind from all directions) and the high relative speed environment (e.g. retreating main rotor blade stall) shall also be provided.		√	√	3.g	√
9.2.3	Fundamental aircraft vibration cues, to include primary main rotor speed and disc loading cues, translational lift and speed change cues (acceleration and deceleration), and general abnormal vibration cues.	√	√	√		√
9.3	VIBRATION AND BUFFET CUES					
9.3.1	Objective vibrations tests are required and shall include recorded results that allow the comparison of relative amplitudes versus frequency: (1) For relevant frequencies up to at least 20 Hz for aeroplanes, and up to the main rotor n/rev frequency for rotorcraft (2) For at least 3 axes, x, y and z, to represent the effects as experienced in the aircraft:			√	3.g	√

9: VIBRATION CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
9.3.2	The FSTD shall be programmed and instrumented using an accelerometer in such a manner that the characteristic vibration/buffet modes can be measured by the objective tests.			✓		✓
9.3.3	For aeroplanes: (1) Buffets on the ground due to thrust effect with brakes set; (2) Buffets on the ground due to spoiler/speedbrake extension and thrust reversal; (3) Buffet during extension and retraction of landing gear; (4) Buffet in the air due to flap and spoiler/speedbrake extension; (5) Mach and manoeuvre buffet; and (6) Approach-to-stall buffet and stall buffet (where applicable); If there are known flight conditions where buffet is the first indication of the stall, or where no stall buffet occurs, this characteristic shall be included in the model. Objective test for stall buffet is required only for FSTDs that are to be qualified for full-stall training tasks or for those aircraft which exhibit stall buffet before the activation of the stall warning system.			✓	3.g	✓
9.3.4	For aeroplanes: (1) Buffets on the ground due to thrust effect with brakes set; (2) Buffets on the ground due to spoiler/speedbrake extension and thrust reversal; (3) Buffet during extension and retraction of landing gear; (4) Buffet in the air due to flap and spoiler/speedbrake extension; (5) Mach and manoeuvre buffet; and (6) Approach-to-stall buffet and stall buffet (where applicable); If there are known flight conditions where buffet is the first indication of the stall, or where no stall buffet occurs, this characteristic shall be included in the model.		✓			✓

9: VIBRATION CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
9.3.5	For rotorcraft: (1) Lift/thrust system vibration effects. For example, primary main rotor speed and disk loading vibration effects; (2) Buffet due to translational lift and effect of speed changes; (3) Buffets due to transverse flow effects; (4) buffet during extension and retraction of landing gear (if applicable to the simulated aircraft); (5) Buffet due to retreating blade stall; (6) Buffet due to vortex ring (setting with power); (7) High speed rotor vibration; and (8) Vibration due to icing effects. If the simulated rotorcraft type is equipped with a vibration reduction system, the FSTD's vibration cues shall also simulate the situation where the vibration reduction system is inoperative.		✓	✓	3.g	✓
9.3.6	For rotorcraft: The FSTD shall provide vibration and buffet effects to include the following as applicable to the simulated aircraft class or group: (1) Primary main rotor speed and disk loading vibration effects; (2) Buffet due to translational lift and effect of speed changes; and (3) Buffet due to abnormal system conditions.	✓				✓

GM1 CS FSTD.QB.109 FSTD general requirements for Vibration Cueing

Summaries of the fidelity levels for the Vibration Cueing feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.109.

9: VIBRATION CUEING
Specific: Vibrations and buffets that result from operation of the aircraft which can be sensed in the flight deck replicate the simulated aircraft in so far as the vibration or buffet marks an event or aircraft state that can be sensed in the flight deck.
Representative: Vibrations and buffets that result from operation of the aircraft which can be sensed in the flight deck are characteristic of the simulated aircraft in so far as the vibration or buffet marks an event or aircraft state that can be sensed in the flight deck.
Generic: Vibrations and buffets that result from operation of the aircraft which can be sensed in the flight deck are characteristic of the simulated aircraft class or group in so far as the vibration or buffet marks an event or aircraft state that can be sensed in the flight deck.

GM2 CS FSTD.QB.109 FSTD general requirements for vibration cues

The Vibration Cueing feature covers the aircraft vibrations and buffet cues that are experienced in the aircraft flight deck. Some cues are intended to replicate cues in the aircraft, and are therefore also objectively verified. Other cues are simulation effects (which may be artificial) to provide general cues to the effect that pilots would experience, but may not necessarily replicate what the aircraft will do.

It is recognised that the vibration cues for fidelity level S may not necessarily be a perfect replication of the simulated type and variant, but will be validated objectively against aircraft type data in addition to the subjective validation.

Vibration or buffet cueing may be triggered by any factor related to operation of the aircraft. The words ‘operation of the aircraft’ should be understood to mean manoeuvring the aircraft (e.g. changes in attitude, altitude, angle of attack, load factor, airspeed, thrust, etc.), changes in the airframe shape (e.g. usage of slats or flaps, extension of speedbrake, extension of a ram air turbine, opening of a door, use of tilting external lights, etc.) or usage of the aircraft systems that may affect vibrations or buffets.

GM3 CS FSTD.QB.109 Vibration systems for rotorcraft

(a) The role of vibrations in pilot cueing

(1) Motion feedback in rotary wing aircraft has a wide bandwidth of frequencies and amplitudes consisting of cues ranging from large sustained accelerations up to high frequency vibrations generated by the rotor harmonics. Vibrations on helicopters, in

addition to creating a harsh operating environment, provide pilots with rotor dynamic feedback critical to their ability to control the aircraft. Normal and abnormal flying conditions are therefore sensed by the pilots through the vibration levels and amplitudes and are integral to helicopter flying. Rotor malfunctions or conditions such as icing or damage are rapidly identified subjectively by sensing the increased vibration levels and change in characteristics.

(2) The FSTD training environment should subject the pilot to high fidelity and realistic levels of vibration in order to enhance the transfer of training. Vibrations, when accurately simulated and harmonised with visual and sound system cues, ensure that the pilot develops proper control strategies while experiencing representative workloads.

(3) Having recognized the importance of vibration cueing for helicopter training it is important to notice that such cueing effects in the FSTD may be produced by using several types of devices with a range of complexity and fidelity levels, from the vibrating seat using a mechanical or acoustical driving system, to the three degree of-freedom (3 DOF) vibration platform complementing the motion system that may be installed on the FSTD. Although this attachment discusses the various solutions for integrating a 3 DOF vibration platform on an FSTD equipped with a motion system, one should keep in mind that even an FSTD with lower fidelity vibration cueing may be equipped with a rather simple vibration system in order to provide the permanent vibrating environment and more specifically the transition of variable cueing relating to changes in flight condition or abnormal effects that contribute to the situation awareness that the pilot should be trained to maintain and react to.

(4) Three characteristics of the vibrations must be accurately reproduced to create an authentic flying environment and stimulate pilots with representative aircraft vibrations: the trends, the axes and the levels of vibrations. For example, the vibration trends will inform the pilot that the helicopter has entered a transition stage between hover and low speed level flight. Helicopter vibrations are multidimensional and are perceived as occurring in more than one degree-of-freedom at a time. Simulating combinations of vibrations in the X, Y and Z axes has been demonstrated to be significant for pilot training. Accurate reproduction of vibration levels provides subjective information on the stresses that certain manoeuvres exert on the helicopter.

(b) Limitations of using a 6-degree-of-freedom motion system to reproduce vibrations

(1) The simulation of vibration cues for rotorcraft as produced by a conventional six degree-of freedom (6 DOF) motion system is limited. While most motion systems are capable of reproducing vibrations, the dynamic range of helicopter vibration amplitudes and frequencies (typically 3 Hz to 50 Hz) exceeds the limited bandwidth capability of synergistic motion systems (typically up to 10 Hz in the vertical axis and less than 10 Hz in the longitudinal and lateral axes).

(2) Moreover, the application of representative vibrations to the entire FSTD structure may adversely impact the life span of some FSTD components, such as the visual system.

(c) Advantages of a dedicated 3-degree-of-freedom vibration system

(1) To augment the performance of a 6 DOF motion system and achieve accurate reproduction of vibrations while minimising stresses on the FSTD structure, the

motion cueing frequency bandwidth may be separated in two. Dedicated cueing devices would then be assigned to reproduce each specific frequency range. The lower frequency range is used to drive the motion system, and the higher frequency range, with the majority of the vibration information, is used to drive a vibration system.

(2) Two solutions may be used for simulating the vibration with 3 DOFs:

(I) A vibration system consisting of a 3 degree-of-freedom system tailored for vibrations and installed under the flight deck as illustrated in Figure 1. This system combines high bandwidth, independent driving axes (to avoid crosstalk) and high stiffness.

(II) A vibration system consisting of a 3 degree-of-freedom system to make the seats, the controls and the main instrument board vibrate independently from the flight deck. This solution decreases the moving mass relatively to the payload and therefore minimises the risk of resonance.

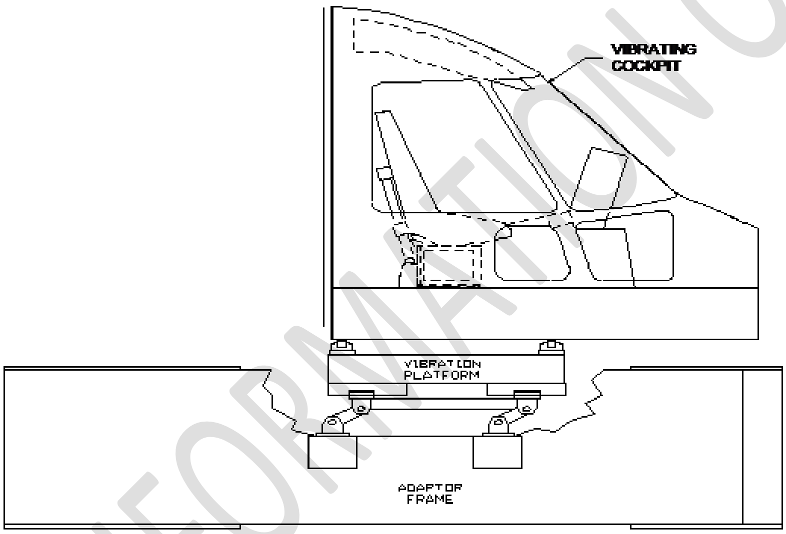

Figure 1: An example of a three degree-of-freedom flight deck vibration system

MOTION CUEING (MTN)

CS FSTD.QB.110 FSTD general requirements for Motion Cueing (MTN)

10: MOTION CUEING
Defines the requirements on the motion cues that are generated by aircraft accelerations (due to forces on flight and ground operations) and by effects of certain events or situations. Note: This feature does not contain the vibration and buffet cues. See 'Vibration Cueing' feature in CS FSTD.QB.109 for their requirements.

The general requirements for the Motion Cueing feature are presented in the table below.

10: MOTION CUEING							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
10.1	MOTION CUES GENERAL					
10.1.1	A motion system having a minimum of 6 degrees of freedom (DOF) shall be fitted. The pilot receives an effective motion cue and stimulus, which provides the appropriate sensations of acceleration of the aircraft's 6 degrees of freedom. The motion system shall be capable of generating sustained acceleration cues and generating the key acceleration and angular cues that are characteristic of the type of aircraft in all axes for all the applicable manoeuvres (e.g. taxiing, take-off, rotation, climb, turns, approach, flare, landing, engine failures, emergencies, etc.). The FSTD motion cueing system shall have a high tilt coordination gain, high rotational gain, and high correlation with respect to the aircraft simulation model. The cues replicate aircraft accelerations, angular rates and motion effects (e.g. landing bumps) to the maximum extent possible within the			✓	3.e 3.f	✓

10: MOTION CUEING							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
	physical limitations of the motion system. The motion cueing performance and repeatability related to aircraft accelerations and manoeuvres shall be demonstrated for the applicable manoeuvres. The Statement of Justification shall explain in detail the selected motion technology and envelopes (both the envelope reached physically and the envelope that the cueing uses). The Statement of Justification shall explain the physical magnitude or the motion movements and washouts used by the cueing for the applicable objective cueing performance signature tests.					
10.1.2	For aeroplane FSTDs to be qualified for UPRT: For motion feature fidelity level S devices, special consideration is given to the motion system response during upset prevention and recovery and approach-to-stall or stall recovery manoeuvres. Notwithstanding the limitations of the motion system, the operator shall place particular emphasis on tuning out objectionable motion system responses, where possible.			√		√
10.1.3	A motion system having a minimum of 3 degrees of freedom (DOF) for pitch, roll and heave shall be fitted. The pilot receives motion cue and stimulus, which provides the appropriate sensations of acceleration. The motion system shall be capable of generating sustained acceleration cues and generating the key acceleration and angular cues that are characteristic of the type of aircraft in the appropriate axes. The Statement of Justification shall explain in detail the selected motion technology, envelopes (both the envelope reached physically and the envelope that the cueing uses) and the physical magnitude and washout used by the cueing for the applicable manoeuvres.		√		3.e 3.f	√
10.1.4	The cross-coupling effects of the motion movements shall be compensated so that they are not discernible by a human during flight. Motion cues shall always provide a correct sensation and provide positive cues for training purposes. Inappropriate cues that could contribute to negative transfer of training are not acceptable. The short term cueing and the long term cueing shall be coordinated and blended together.		√	√		√

10: MOTION CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
10.1.5	The washout shall be so slow that it is not sensed by a human during flight.		✓	✓		✓
10.1.6	A cueing system providing only motion effects shall be fitted. Cues on the aircraft accelerations or attitudes are not required at this fidelity level. If such capabilities are simulated, they shall comply with level R requirements. The Statement of Justification shall explain in detail what motion effects are simulated and how.	✓				✓
10.2	MOTION SYSTEM PERFORMANCE					
10.2.1	The motion system performance (e.g. frequency response) shall comply with the objective test requirements.		✓	✓	3.a, 3.b, 3.c	✓
10.3	MOTION EFFECTS FOR AEROPLANE FSTDS: This section describes the motion special effects for the simulated aircraft cueing.					
10.3.1	Motion effects for an aeroplane FSTD shall give cues realistic to the simulated aircraft type and variant to indicate the threshold at which a flight crew member shall recognize an event or situation. The following cues shall be given on all the appropriate axis (6 DOF) as applicable for the event or situation: (1) effects of runway and taxiway rumble, oleo deflections, groundspeed, uneven runway, runway contamination with associated anti-skid characteristics, running over runway centreline lights and taxiway characteristics; (2) bumps associated with the landing gear mechanism movement; (3) touchdown cues for main and nose gear; (4) nosewheel scuffing; (5) tyre failure; (6) engine damage; and (7) tail, pod and wing strike.			✓		✓

10: MOTION CUEING						
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**	
		G	**R**	**S**	**QTG**	**F&S**
10.3.2	Motion effects for an aeroplane FSTD shall give cues characteristic to the simulated aircraft type to indicate the threshold at which a flight crew member shall recognize an event or situation. The following cues shall be given at least on the heave axis as applicable for the event or situation: (1) effects of runway and taxiway rumble, oleo deflections, groundspeed, uneven runway, runway contamination with associated anti-skid characteristics, running over runway centreline lights and taxiway characteristics; (2) bumps associated with the landing gear mechanism movement; (3) touchdown cues for main and nose gear; (4) nosewheel scuffing; (5) tyre failure; (6) engine damage; and (7) tail, pod and wing strike.		✓			✓
10.3.3	Touchdown cues shall reflect the effects of lateral and directional cues resulting from crab or crosswind landings, as well as from rate of descent.		✓	✓		✓
10.3.4	Motion effects for an aeroplane FSTD shall give cues characteristic to the simulated aircraft class or group to indicate the threshold at which a flight crew member shall recognize an event or situation. The following cues shall be given at least on the heave axis as applicable for the event or situation: (1) effects of runway and taxiway rumble, oleo deflections, uneven runway, runway contamination with associated anti-skid characteristics, running over runway centre line lights characteristics (such effects shall be a function of groundspeed); (2) touchdown cues for main and nose gear; (3) nosewheel scuffing; (4) engine damage.	✓				✓
10.4	MOTION EFFECTS FOR ROTORCRAFT FSTDs:					

10: MOTION CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
	This section describes the motion special effects for the simulated aircraft cueing.					
10.4.1	Motion effects for a rotorcraft FSTD shall give cues realistic to the simulated aircraft type and variant to indicate the threshold at which a flight crew member shall recognize an event or situation. The following cues shall be given on all the appropriate axis (6 DOF) as applicable for the event or situation: (1) effects of runway and taxiway rumble, oleo deflections, groundspeed, uneven runway, runway contamination, running over runway centreline lights and taxiway characteristics; (2) touchdown cues for main and nose gear or for skids, based on their geometry; (3) ground resonance; (4) tyre failure; and (5) airframe ground strike (e.g. tail strike).			√		√
10.4.2	Motion effects for a rotorcraft FSTD shall give cues characteristic to the simulated aircraft type to indicate the threshold at which a flight crew member shall recognize an event or situation. The following cues shall be given at least on the heave axis as applicable for the event or situation: (1) touchdown cues for main and nose gear or for skids, based on their geometry; (2) ground resonance; (3) tyre failure; and (4) airframe ground strike (e.g. tail strike).		√			√
10.4.3	Touchdown cues shall reflect the effects of lateral and directional cues resulting from crab or crosswind landings, as well as from rate of descent.		√	√		√
10.4.4	Motion effects for a rotorcraft FSTD shall give cues characteristic to the simulated aircraft class or group to indicate the threshold at which a flight crew member shall recognize an event or situation. The following cues shall be given at least on the heave axis as applicable for the event or situation:	√				√

10: MOTION CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
	(1) touchdown cues for main and nose gear or for skids; (2) tyre failure; and (3) airframe ground strike (e.g. tail strike).					
10.5	MOTION SYSTEM SAFETY					
10.5.1	The motion system shall have a safety mechanism to monitor and ensure that the motion performs only the commanded movements and stops in case of uncommanded movements.	✓	✓	✓		
10.5.2	The motion system shall have easily accessible emergency stop buttons available for the instructor and flight crew. The button for the flight crew shall be located so that it does not appear as part of the simulated flight deck.	✓	✓	✓		

GM1 CS FSTD.QB.110 FSTD general requirements for Motion Cueing

Summaries of the fidelity levels for the Motion Cueing feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.110.

10: MOTION CUEING
Specific: The pilot receives an effective motion cues and stimuli, which provides the appropriate sensations of accelerations of the aircraft's 6 degrees of freedom (DOF). Motion cues have a high correlation with respect to the aircraft movements.
Representative: The pilot receives motion cues and stimuli that provide appropriate sensations of accelerations. The sensations of motion may be less than those at fidelity level S; for example, the magnitude of the cues may be reduced.
Generic: The pilot receives motion effects, such as touchdown cues, engine damage and runway rumble. Cues on the aircraft accelerations or attitudes are not required at this level.

GM2 CS FSTD.QB.110 FSTD general requirements for Motion Cueing

The Motion Cueing feature covers the aircraft motion and acceleration cues that are experienced in the aircraft flight deck to enhance the simulation experience and training effectiveness. A motion system can't provide or sustain the same accelerations as the pilots feel in real aircraft because of the limited size and envelope of the motion system. Some cues are intended to replicate the aircraft motions, and are therefore also objectively verified. Other cues are simulation effects (which may be artificial) to provide general cues to the effect that pilots would experience, but may not necessarily replicate what the aircraft will do.

It is recognised that the physical space and mechanics of the motion system may limit the range and fidelity of motion cueing that can be realistically reproduced. Motion systems often exhibit cross-couplings between axes, necessitating careful consideration of cue strength to avoid misleading or incorrect cues. To minimise the impact of incorrect cues, it may be necessary to down-scale the motion envelope. However, this approach can significantly affect the perception of correct cues as well. For more information, see GM1 FSTD.QTG.A.300.

VISUAL CUEING (VIS)

CS FSTD.QB.111 FSTD general requirements for Visual Cueing (VIS)

11: VISUAL CUEING
Defines the type of out-of-flight-deck window image display (e.g. collimated or non-collimated) and field of view (horizontal and vertical) that is required to be seen by the pilots using the FSTD from their reference eyepoint(s). Note: This feature concerns the qualities and capabilities of the visual image. For requirements on the contents of the visual image (e.g. runway, lights, terrain, buildings, etc.), see features 'Operating Sites And Terrain' in CS FSTD.QB.114 and 'Atmosphere And Weather' in CS FSTD.QB.113.

The general requirements for the Visual Cueing feature are presented in the table below.

11: VISUAL CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.1	DISPLAY SYSTEM					
11.1.1	The system shall be free from optical discontinuities and artefacts that create non-realistic cues. Artefacts may include, but are not limited to, colour balance, colour correctness, incorrect image movement, aliasing, or edge blending issues. If the system consists of multiple channels, they shall have the same image quality (within the minimum required field of view and the image shall continue smoothly between channels (i.e. edge blending) for day, twilight and night). Visible joins or edges (i.e. sharp contours) in the image from adjoining display surfaces may be acceptable where necessary, but shall be minimised.	✓	✓	✓		✓
11.1.2	The computational resources for the visual system shall be sufficient to ensure a stable visual display.	✓	✓	✓		✓

11: VISUAL CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.2	DISPLAY GEOMETRY					
11.2.1	The geometry shall be presented on the visual display correctly. The Statement of Justification shall explain the geometry of the installation.		✓	✓		✓
11.2.2	The geometry of image shall have no distracting discontinuities	✓	✓	✓		✓
11.3	DISPLAY FIELD OF VIEW FOR AEROPLANES					
11.3.1	Field of view in the training device replicates the aircraft field of view (without obstruction). Where appropriate for the training task(s) and aircraft type, an extended FOV (e.g. chin, eyebrow windows) shall be provided. These tasks may include take-offs, departures, approaches and landings.			✓		✓
11.3.2	Continuous collimated FOV of at least 200° horizontally and 40° vertically FOV for each pilot simultaneously. The display shall be sufficient to provide peripheral vision cues.			✓	4.a.1	
11.3.3	Continuous FOV of at least 200° horizontally and 40° vertically for each pilot simultaneously. The visual system need not be collimated.		✓		4.a.1	
11.3.4	A field of view of a minimum of 45° horizontally and 30° vertically, unless restricted by the type of aircraft, simultaneously for each pilot. The display may consist of one or more flat screens. The visual system need not be collimated.	✓			4.a.1	
11.3.5	If a visual system is fitted, the field of view from the flight deck at the pilot reference eyepoint shall be limited in accordance with the windows of the simulated aircraft.	✓	✓	✓		✓
11.4	DISPLAY FIELD OF VIEW FOR ROTORCRAFT					

11: VISUAL CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.4.1	Field of view in the training device replicates the aircraft field of view without obstruction. Where appropriate for the training task(s) and aircraft type, an extended FOV, including chin windows, shall be provided. These tasks may include take-offs, departures, approaches and landings in confined areas, on sloping ground, in snow/sand/etc., on a rig or a ship, etc.			✓		✓
11.4.2	Continuous FOV of at least 180° horizontally and 60° vertically FOV for each pilot simultaneously. The display shall be sufficient to provide peripheral vision cues. The visual system need not be collimated.			✓	4.a.1	
11.4.3	Continuous FOV of at least 150° horizontally and 60° vertically for each pilot simultaneously. The visual system need not be collimated.		✓		4.a.1	
11.4.4	A field of view of a minimum of 150° horizontally and 40° vertically, unless restricted by the type of aircraft, simultaneously for each pilot. The display may consist of one or more flat screens. The visual system need not be collimated.	✓			4.a.1	
11.4.5	The vertical FOV shall be distributed such that 20° is above the horizon and 40° is below, unless the simulated rotorcraft justifies an alternative FOV distribution.		✓	✓	4.a.2	
11.4.6	The vertical FOV shall be distributed such that 15° is above the horizon and 25° is below, unless the simulated rotorcraft justifies an alternative FOV distribution.	✓			4.a.2	
11.5	NON-COLLIMATED					
11.5.1	For Aeroplanes (using non-collimated or direct-projection displays): The parallax effects shall be minimised - the parallax error shall be at or less than 10° simultaneously for each pilot, when aligned for the point midway between the left and right seat eyepoints. When the image is aligned to the pilot flying, the misalignment observed by the non-flying pilot shall not exceed 20°. The Statement of Justification shall contain verification of this requirement.	✓	✓	✓		✓

11: VISUAL CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.5.2	For Rotorcraft (using non-collimated or direct-projection displays): The parallax effects shall be minimised. The Statement of Justification shall contain verification of this requirement.	✓	✓	✓		✓
11.5.3	The minimum distance from the pilot's eye position to the surface of a direct view display may not be less than the distance to any front panel instrument.	✓				
11.5.4	The visual system shall have the capability to align at any time to each of the pilot eye positions (pilot, co-pilot), as well as to the midpoint for the flight deck.	✓	✓	✓		✓
11.6	DISPLAY SURFACE RESOLUTION					
11.6.1	Display surface resolution demonstrated by a test pattern of objects shown to occupy a visual angle of not greater than 2 arc minutes in the visual display used on a scene from the pilot's eye point.			✓	4.a.3	
11.6.2	Display surface resolution demonstrated by a test pattern of objects shown to occupy a visual angle of not greater than 3 arc minutes in the visual display used on a scene from the pilot's eye point.		✓		4.a.3	
11.6.3	Display surface resolution demonstrated by a test pattern of objects shown to occupy a visual angle of not greater than 4 arc minutes in the visual display used on a scene from the pilot's eye point.	✓			4.a.3	
11.7	LIGHT-POINT SIZE					
11.7.1	Light-point size not greater than 5 arc minutes. The Statement of Justification shall confirm that the test pattern represents lights used for airport lighting.			✓	4.a.4	
11.7.2	Light-point size not greater than 8 arc minutes. The Statement of Justification shall confirm that the test pattern represents lights used for airport lighting.	✓	✓		4.a.4	

11: VISUAL CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.8	DISPLAY CONTRAST RATIO					
11.8.1	Display contrast ratio adequate to clearly identify image features and not less than 8:1.			✓	4.a.5	
11.8.2	Display contrast ratio adequate to clearly identify image features and not less than 5:1.		✓		4.a.5	
11.8.3	Display contrast ratio adequate to clearly identify image features and not less than 4:1.	✓			4.a.5	
11.9	LIGHT-POINT CONTRAST RATIO					
11.9.1	Light-point contrast ratio sufficient to clearly identify illumination sources and lights and not less than 25:1.			✓	4.a.6	
11.9.2	Light-point contrast ratio sufficient to identify lights and not less than 10:1.		✓		4.a.6	
11.9.3	Light-point contrast ratio sufficient to identify lights and not less than 8:1.	✓			4.a.6	
11.10	LIGHT-POINT BRIGHTNESS					
11.10.1	Light-point brightness not less than 20 cd/m^2 (5.8 foot-lamberts).		✓	✓	4.a.7	
11.10.2	Light-point brightness shall be sufficient to be able to clearly identify features in the visual scene.	✓				✓
11.11	DISPLAY SURFACE BRIGHTNESS					
11.11.1	Surface brightness shall not be less than 20 cd/m^2 (5.8. foot-lamberts) at any point across the entire field of view.			✓	4.a.8	
11.11.2	Surface brightness shall not be less than 14 cd/m^2 (4.1 foot-lamberts) at any point across the entire field of view.		✓		4.a.8	
11.11.4	Surface brightness shall be sufficient to be able to clearly identify features in the visual scene.	✓				✓

11: VISUAL CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.12	BLACK LEVEL AND SEQUENTIAL CONTRAST (where applicable to the visual display technology used on the FSTD)					
11.12.1	Black level and sequential contrast shall be measured to determine it is sufficient for training in all times of day.		✓	✓	4.a.9	✓
11.13	MOTION BLUR (where applicable to the visual display technology used on the FSTD)					
11.13.1	Tests are required to determine the amount of motion blur that is typical of certain types of display equipment. A test shall be provided that demonstrates the amount of blurring at a predefined rate of movement across the image.		✓	✓	4.a.10	✓
11.14	SPECKLE TEST (where applicable to the visual display technology used on the FSTD)					
11.14.1	A speckle test is required to demonstrate that the speckle is below a distracting level.		✓	✓	4.a.11	✓
11.15	VISUAL GROUND SEGMENT					
11.15.1	The ground segment visible to the pilot when conducting a landing movement in day, twilight and night low visibility conforms to the simulated aircraft.	✓	✓	✓	4.e.1	✓
11.16	CRASH EFFECTS					
11.16.1	The visual system shall have an effect for a crash for example when impacting with ground structures or another aircraft, or exceeding structural or flight envelope limitations.	✓	✓	✓		✓
11.17	VISUAL SCENE CONTENT					

11: VISUAL CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.17.1	The visual system shall be capable of producing, as a minimum, scene content comparable in detail to that produced by 10 000 polygons and 5 000 visible light-points for night, twilight and day scenes for the entire visual system.			✓		
11.17.2	The visual system shall be capable of producing, as a minimum, scene content comparable in detail to that produced by 6 000 polygons and 5 000 visible light-points for night, twilight and day scenes for the entire visual system.		✓			
11.17.3	The visual system shall be capable of producing, as a minimum, scene content comparable in detail to that produced by 6 000 polygons and 1 000 visible light-points for night, twilight and day scenes for the entire visual system.	✓				
11.17.4	Total visual scene content comparable in detail to that produced by 3 500 visible textured surfaces and 5 000 visible lights shall be provided.	✓				
11.18	VISUAL SCENE					
11.18.1	Continuous and sufficient horizontal and vertical field of view specific to the aircraft being simulated from the handling pilot's normal eyepoint with detailed close-up perspective and textured representation of all ambient conditions for each pilot.			✓		✓
11.18.2	Visual cues to assess the rate of change of height, height AGL and translational displacements and rates, during take-off, low altitude/low airspeed manoeuvring, hover, and landing. This shall include: (1) Surface on runways, taxiways, and ramps; and (2) Terrain features.			✓		✓
11.18.3	Visual cues to assess the rate of change of height and translational displacements and rates, during take-off and landing.		✓			✓

11: VISUAL CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.18.4	Visual fidelity: the visual scene displays an identifiable horizon in day and night VFR conditions suitable for determining the aircraft attitude in the pitch, roll and yaw axes.	√	√	√		√
11.18.5	The system shall be capable of displaying contoured terrain at the resolution demanded by the environment.			√		√
11.18.6	Landing area(s) provided shall be visible from a distance sufficient to allow the pilot to establish, stabilise and maintain approach angles from the intended 3D final approach position to land according to aircraft performance.		√	√		√
11.18.7	Landing area(s) provided shall be visible from a distance sufficient to allow the pilot to establish, stabilise and maintain a shallow approach angle (less than 5°) from 300 m (1 000 ft) AGL to the surface unless obstructed by the flight deck structure.	√				√
11.18.8	Focus and clarity of terrain and ground objects shall be sharp.		√	√		√
11.18.9	Surface shading effects shall be consistent with simulated sun position. Shadows of 3D objects and lighting effects appropriate to directionality of light (e.g. sunshine). Surface shading effects shall be consistent with simulated sun position and shall include shadows from objects, consistent with the simulated sun position.			√		√
11.18.10	The FSTD shall have operational aircraft landing lights for night scenes. Where twilight scenes are available, operational landing lights are required.		√	√		√

11: VISUAL CUEING							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.18.11	The visual system shall be capable of displaying ground static and moving traffic and airborne traffic capable of conflicting with ownship. Integration of the aircraft systems and the visual image: If an aircraft system provides information on the other traffic (e.g. ACAS/TCAS system), the visual image shall correspond to the information provided by the system (e.g. bearing, distance and altitude of the traffic).		✓	✓		✓
11.18.12	For aircraft capable of landing on water (e.g. seaplanes, rotorcraft equipped with floats), the following effects shall be capable of being displayed (as applicable): (1) sea states; (2) effects of wind lanes on water surface;		✓	✓		✓
11.18.13	The visual system shall display the ownship parts that are visible within the field of view (e.g. wings, nacelles, propellers, spinners, rotors, etc.). The size and shape of those parts shall replicate the simulated aircraft type and variant. Any movement (e.g. ailerons, propellers, rotors, etc.) shall be displayed and shall replicate the simulated aircraft type and variant.			✓		✓
11.18.14	The visual system shall display the ownship parts that are visible within the field of view (e.g. wings, nacelles, propellers, spinners, rotors, etc.). The size and shape of those parts shall be characteristic of the simulated aircraft type. Any movement (e.g. ailerons, propellers, rotors, etc.) shall be displayed and shall be characteristic of the simulated aircraft type.		✓			✓

11: VISUAL CUEING							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.18.15	The visual system shall display the ownship parts that are visible within the field of view (e.g. wings, nacelles, propellers, spinners, rotors, etc.). The size and shape of those parts shall be characteristic of the simulated class or group. Any movement (e.g. ailerons, propellers, rotors, etc.) shall be displayed and shall be characteristic of the simulated class or group and shall correspond to the other aircraft features (e.g. propellers turning in the same direction as in the flight dynamics model).	√				√
11.18.16	The visual system shall display the icing effects on the aircraft parts that are visible within the field of view (e.g. wing leading edges, spinners, etc.).	√	√	√		√
11.18.17	Visual cues to assess sink rate and enable depth perception during take-off and landing shall be provided.		√	√		√
11.18.18	The visual scene shall be free of any negative impact due to any flight deck ambient lighting, IOS or room lighting (e.g. reduction of contrast, etc.).	√	√	√		√
11.19	NIGHT VISION IMAGING SYSTEMS (NVIS) (where applicable) See CS FSTD.QB.140.					
11.19.2	Visible black level: The display brightness for a low visibility night scene, when configured for NVIS operations, shall be no more than 0.01 candelas/square metre (cd/m²).			√	4.d.1	√
11.19.3	NVIS surface brightness: When configured for NVIS operation the surface brightness shall not be less than 3.4 cd/m² (1 foot-lambert).			√	4.d.2	√
11.19.4	NVIS surface contrast ratio: NVIS surface contrast ratio shall be a minimum of 4:1			√	4.d.3	√
11.19.5	Lunar illumination: The luminance of a full white Lambertian surface under 100% lunar illumination at 90° elevation (moon directly overhead) with clear atmospheric conditions shall be between 0.075 cd/m² and 1.025 cd/m².			√	4.d.4	√

11: VISUAL CUEING							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.19.6	NVIS image colour: There shall be no distracting colour shift from white light in the unaided view. Scenes that exhibit an unrealistic colour tint are not acceptable.			✓		✓
11.19.7	NVIS surface resolution: Surface resolution shall be no greater than five (5) arc minutes when viewed through the NVG under 100% moon luminescence.			✓	4.d.5	✓
11.20	XR SYSTEMS: HEAD MOUNTED DISPLAYS See CS FSTD.QB.150.					
11.20.1	FSTDs fitted with a head mounted display for the visual system that uses virtual reality shall meet the requirements for VR Displays.	✓	✓	✓		
11.21	XR SYSTEMS: VR DISPLAY - HEADSET SYSTEM REQUIREMENTS Note: Requirements marked with ✓[1] indicate that an objective test section for these is not available. The tests shall be defined in the Special Conditions.					
11.21.1	The visible scene shall be measured as a field of view (FOV) and field of regard (FOR). The image shall be consistent within the observable field of view.		✓	✓	✓[1]	✓
11.21.2	A binocular field of view for the VR Display headset of a minimum of 80° horizontally and 65° vertically.		✓	✓	✓[1]	✓
11.21.3	The geometry of the visual representation shall be correct and free of noticeable distortion. The system shall be measured with respect to absolute and relative geometrical characteristics (deg and deg/deg) with a two-dimensional grid of minimum 1° over the entire FOV.		✓	✓	✓[1]	✓
11.21.4	The computational resources for the visual system shall be sufficient to ensure a stable frame rate.	✓	✓	✓	✓[1]	✓
11.21.5	If night scene training is applicable for the FSTD, the visual system shall provide sufficient contrast and black level.		✓	✓	✓[1]	✓

11: VISUAL CUEING						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
11.21.6	The resolution of the systems used shall be sufficient to ensure readability of the relevant flight deck elements. Resolution characteristics shall be tested over the entire FOV. The operator shall provide procedures to ensure correct visual setup and performance before training.		√	√	√[1]	√
11.21.7	Relevant flight deck colours shall be specific to the aircraft simulated. The relevant colour correctness shall be objectively tested. The colours shall be evenly represented across the display.			√	√[1]	√
11.21.8	Relevant flight deck colours shall be representative of the aircraft simulated and be consistent during simulation. The representativeness of relevant colours shall be objectively tested, with respect to degradation of relevant systems. The colours shall be evenly represented across the display.	√	√		√[1]	√
11.21.9	Where applicable, depth perception in the VR Display shall be objectively demonstrated.		√	√	√[1]	√
11.21.10	Where applicable, the IPD setting of the headset shall be verified.		√	√	√[1]	√
11.21.11	Any HMD particular feature used that may impact the visual representation shall be assessed against risks of malfunction and degradation, e.g. automatic IPD, foveated rendering, HMD tracking, colour calibration, automatic exposure or white balancing. Means to monitor system integrity during operation shall be implemented.	√	√	√		√

GM1 CS FSTD.QB.111 FSTD general requirements for Visual Cueing

Summaries of the fidelity levels for the Visual Cueing feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.111.

11: VISUAL CUEING
Specific: Continuous sufficient horizontal and vertical field of view specific to the aircraft being simulated, from the handling pilot's reference eyepoint with detailed close-up perspective and textured representation of all ambient conditions for each pilot. Visual image qualities are at the highest level. Visual cues to assess the rate of change of height, height AGL and translational displacements and rates, during take-off, low altitude/low airspeed manoeuvring, hover, and landing. The system is capable of displaying contoured terrain at the resolution demanded by the environment. Landing area(s) are visible from a distance sufficient to allow the pilot to establish, stabilise and maintain approach angles from the intended 3D final approach position to land according to aircraft performance.
Representative: Continuous horizontal and vertical field of view to provide peripheral vision cues. Visual image qualities are at the intermediate level. Visual cues to assess the rate of change of height and translational displacements and rates, during take-off and landing. Landing area(s) are visible from a distance sufficient to allow the pilot to establish, stabilise and maintain approach angles from the intended 3D final approach position to land according to aircraft performance.
Generic: The display may consist of one or more flat screens. Visual image qualities are at the lowest level. If a landing area is provided, it is visible from a distance sufficient to allow the pilot to establish, stabilise and maintain a shallow approach angle from 1 000 ft AGL to the surface unless obstructed by the flight deck structure.

GM2 CS FSTD.QB.111 FSTD general requirements for visual cueing

The choice of the display system and of the field of view requirements should fully consider the intended use of the FSTD. The balance between training and testing/checking may influence the choice and field of view of the display system. In addition the diverse operational requirements should be addressed.

Guidance on display types is provided in GM3 CS FSTD.QB.111.

Note: Where a visual display system is fitted even though it is not considered to be fidelity level G, R, or S, it should be assessed to ensure that it does not adversely affect the qualification of the FSTD.

GM3 CS FSTD.QB.111 Visual display systems

This GM provides guidance for the assessment of visual display systems.

(a) Introduction

When selecting a visual system configuration, there are many compromises to be made dependent upon the flight deck geometry, crew complement and intended use of the training device. Some of these compromises and choices regarding display systems are discussed here.

(b) Basic principles of an FSTD collimated display

(1) The essential feature of a collimated display is that light rays coming from a given point in a picture are parallel. There are two main implications of the parallel rays: first the viewer's eyes focus at infinity and have zero convergence thus providing a cue that the object is distant. Second, the angle to any given point in the picture does not change when viewed from a different position, and thus the object behaves geometrically as though it were located at a significant distance from the viewer. These cues are self-consistent, and are appropriate for any object which has been modelled as being at a significant distance from the viewer.

(2) In an ideal situation the rays are perfectly parallel, but most implementations provide only an approximation to the ideal. Typically, an FSTD display provides an image located not closer than about 6-10 m from the viewer, with the distance varying over the field of view. A schematic representation of a collimated display is provided in Figure 1 below.

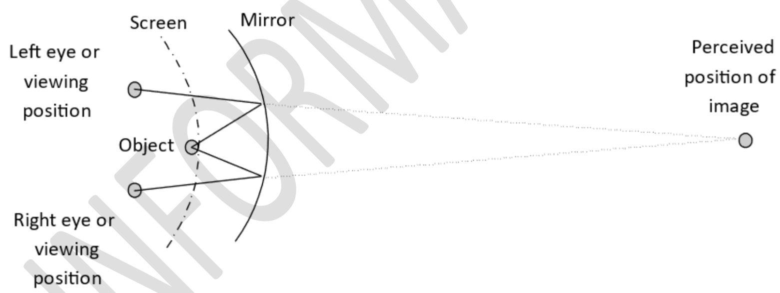

Figure 1: Collimated display

(3) Collimated displays are well-suited to many simulation applications as the area of interest is relatively distant from the observer, and so the angles to objects should remain independent of viewing position. Consider the view of the runway seen by the flight crew lined up on an approach. In the real world the runway is distant, and therefore light rays from the runway to the eyes are parallel. The runway therefore appears to be straight ahead to both crew members. This situation is well-simulated by a collimated display and is presented in Figure 2. Note that the distance to the runway has been shortened for clarity. If drawn to scale, the runway would be farther away and the rays from the two seats would be closer to being parallel.

(4) While the horizontal field of view (FOV) of a collimated display can be extended to approximately 210-220°, the vertical FOV has normally been limited to about 40°-45°. These limitations result from trade-offs in optical quality as well as interference

between the display components and flight deck structures, but were sufficient to meet FSTD regulatory approval for aeroplane and rotorcraft FSTDs. Recently more designs have been introduced with vertical FOVs of up to 60° for some aircraft (e.g. helicopter) applications.

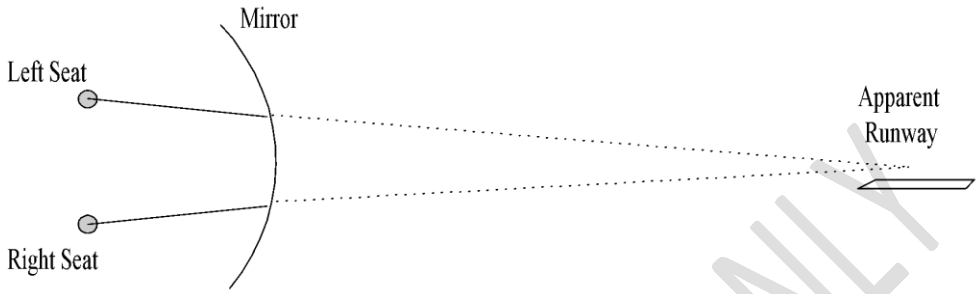

Figure 2: Runway view in a collimated display

(c) Basic principles of an FSTD dome display

(1) The situation in a dome display is shown in Figure 3. As the angles can be correct for only one eye point at a time, the visual system has been calibrated for the right seat eye point position — the runway appears to this viewer to be straight ahead of the aircraft. To the left seat viewer, however, the runway appears to be somewhat to the right of the aircraft. As the aircraft is still moving towards the runway, the perceived velocity vector should be directed towards the runway and this should be interpreted as the aircraft having some yaw offset.

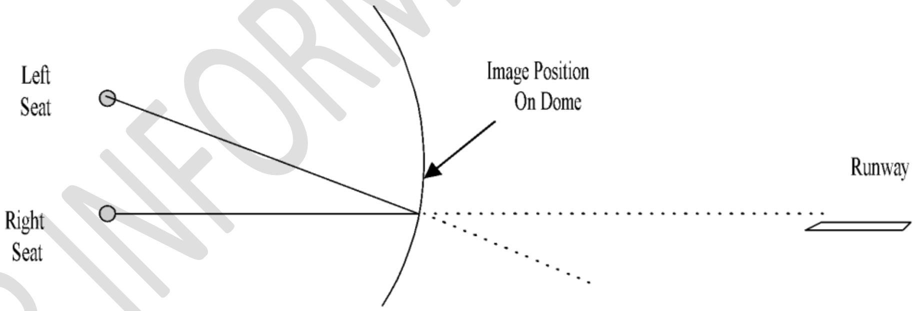

Figure 3: Runway view in a dome display

(2) The situation is substantially different for near field objects such as those that are encountered in some aircraft type (e.g. helicopter) operations close to the ground. Here, objects that should be interpreted as being close to the viewer will be misinterpreted as being distant in a collimated display. The errors can actually be reduced in a dome display as shown in Figure 4 and Figure 5.

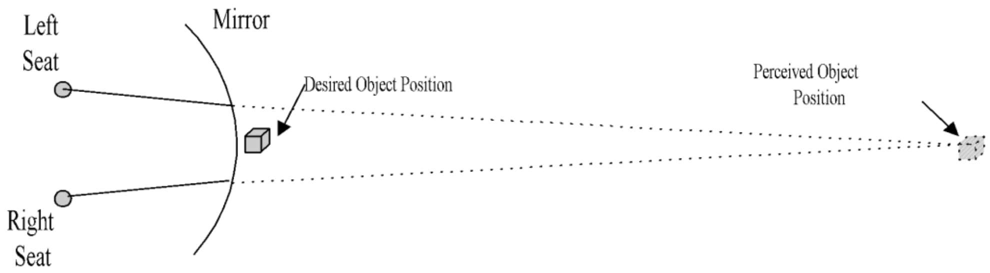

Figure 4: Near field object in a collimated display

(3) The FOV possible with a dome display can be larger than that of a collimated display. Depending on the configuration, a FOV of 240° by 90° is possible and can be exceeded.

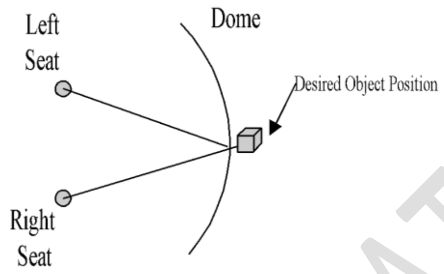

Figure 5: Near field object in a dome display

(d) Additional display considerations

(1) While the situations described above are for discrete viewing positions, the same arguments can be extended to moving eye points such as those that are produced by the viewer moving their head. In the real world, the parallax effects resulting from head movement provide distance cues. The effect is particularly strong for relative movement of flight deck structure in the near field and modelled objects in the distance. Collimated displays provide accurate parallax cues for distant objects, but increasingly inaccurate cues for near field objects. The situation is reversed for dome displays.

(2) Stereopsis cues resulting from the different images presented to each eye for objects relatively close to the viewer also provide depth cues. Yet again, the collimated and dome displays provide more or less accurate cues depending on the modelled distance of the objects being viewed.

(e) Training implications

In view of the basic principles described above, it is clear that neither display approach provides a completely accurate image for all possible object distances. It is therefore important when configuring an FSTD display system to consider the training role of the FSTD. Depending on the training role, either display may be the optimum choice. Factors which should be considered when selecting a design approach should include relative importance of training tasks at low altitudes, the role of the two crew members in the flying tasks, and the FOV required for particular training tasks.

NAVIGATION (NAV)

CS FSTD.QB.112 FSTD general requirements for Navigation (NAV)

12: NAVIGATION
Defines the level of simulation of the navigation aids and networks, such as ILS, VOR, DME, NDB, GNSS (e.g. GPS, SBAS, GBAS, etc. and associated instructor controls. Note: The aircraft navigation equipment and instruments (e.g. NAV receivers, GPS units, etc.) and their databases (e.g. FMS or GPS navigation databases) are considered in the features ‘Flight Deck Layout And Structure’ in CS FSTD.QB.101 and ‘Aircraft Systems’ in CS FSTD.QB.104.

The general requirements for the Navigation feature are presented in the table below.

12: NAVIGATION							
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**		
		G	**R**	**S**	**QTG**	**F&S**
12.1	NAVIGATION DATABASE					
12.1.1	Navigational data to support operations and simulated aircraft systems for real-world operations at least at five airports/operating sites and support operational flight scenarios between two operating sites. Navigational data for the airports/operating sites shall be complete with corresponding 2D and 3D approach procedures.		✓	✓		✓

12: NAVIGATION							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
12.1.2	Navigational data to support operations and simulated aircraft systems at least at five airports/operating sites and support operational flight scenarios between two operating sites. The airports/operating sites and their navigational data may be imaginary in which case associated imaginary charts shall be provided. The charts shall contain the information as in real aviation charts. Navigational data for at least one airport/operating site shall be complete with corresponding 2D and/or 3D approach procedures.	√				√
12.1.3	Navigational data shall be maintained up-to-date as per the aircraft update cycle.			√		
12.1.4	Navigational data shall be updated regularly.		√			
12.1.5	Navigational data shall be capable of being modified or updated.	√				
12.2	INSTRUCTOR CONTROLS AND MALFUNCTIONS					
12.2.1	The instructor station shall have controls of navigational aids (e.g. being able to activate/deactivate navigation aids such as ground stations).	√	√	√		√
12.2.2	The instructor station shall have malfunctions and controls to reduce the GNSS accuracy or availability (e.g. by number of received GNSS satellites one at a time down to zero) below the normal operational limits.			√		√
12.3	ARRIVAL/DEPARTURE FEATURES					
12.3.1	Navigational data shall support the standard arrival and departure procedures at the simulated airports/operating sites.	√	√	√		√
12.4	NAVIGATION AIDS					
12.4.1	Navigation aids shall be usable within range or line of sight without restriction, as applicable to the geographic area, and dependent on the height of the aircraft above the horizon.		√	√		√

12: NAVIGATION						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
12.4.2	Navigation aids shall be usable within range or line of sight.	√				√
12.4.3	Navigational aids shall exhibit realistic characteristics (e.g. level of accuracy, VOR cone of confusion, etc.).	√	√	√		√
12.4.4	Navigational aids shall be aligned appropriately (e.g. note the variation at each simulated airport/operating site)	√	√	√		√

GM1 CS FSTD.QB.112 FSTD general requirements for Navigation

Summaries of the fidelity levels for the Navigation feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.112.

12: NAVIGATION
Specific: Navigational data with the corresponding departure, en-route and arrival/approach/landing facilities for a selection of operating sites. Navigation aids are usable within range or line of sight without restriction, as applicable to the geographic area. Navigational data is maintained up to date as per the aircraft update cycle.
Representative: Navigational data with the corresponding departure, en-route and arrival/approach/landing facilities for a selection of operating sites. Navigation aids are usable within range or line of sight without restriction, as applicable to the geographic area. Navigational data is updated regularly.
Generic: Navigational data with the corresponding departure, en-route and arrival/approach/landing facilities for a selection of operating sites. Navigation aids are usable within range or line of sight. Navigational data may be imaginary, in which case associated imaginary charts are provided. Navigational data might not be updated after the initial installation.

ATMOSPHERE AND WEATHER (ATM)

CS FSTD.QB.113 FSTD general requirements for Atmosphere And Weather (ATM)

13: ATMOSPHERE AND WEATHER
Defines the level of complexity of the simulated weather conditions, from ambient temperature and pressure to full thunderstorm modelling, etc. Note: Requirements of this feature concerning the visual scene are applicable only if a 'Visual Cueing' feature is at level G, R or S. Note: The requirements shall be read in conjunction with CS FSTD.FST.020 and CS FSTD.FST.030 visual requirements (paragraph 13) to fully understand the details to be provided.

The general requirements for the Atmosphere And Weather feature are presented in the table below.

13: ATMOSPHERE AND WEATHER								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION			
		G	R	S	QTG(A)	QTG(H)	F&S	
13.1	ENVIRONMENT SIMULATION							
13.1.2	Fully integrated dynamic environment simulation with weather effects. The environment shall be integrated with the entire simulation.		✓	✓			✓	
13.1.3	A basic atmospheric model including pressure, temperature, visibility, cloud base and winds. The environment shall be sufficient to permit accurate systems operation and indications and be synchronised with appropriate features to provide integrity.	✓					✓	
13.2	ATMOSPHERE SIMULATION							
13.2.1	The standard atmosphere shall be simulated, and the instructor shall have control over key parameters.	✓	✓	✓			✓	

13: ATMOSPHERE AND WEATHER								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
13.2.2	The atmosphere simulation shall include: (1) Wind speed, direction and gusts; (2) Air temperature and its lapse rate; (3) Air pressure; and (4) Turbulence levels;	✓	✓	✓			✓
13.2.3	For devices with no motion system installed, turbulence effects shall be simulated by using other applicable cues on all axes: (1) Effects on instruments; (2) Effects on aerodynamics and handling as a result of the atmospheric disturbances; and (3) Effects on the controls where applicable (e.g. reversible flight controls).	✓	✓	✓			✓
13.3	VISUAL WEATHER REPRESENTATION Note: This section is applicable only if a Visual Cueing feature is simulated and is at fidelity level G, R or S.						
13.3.1	The visual scene shall include the following: (1) Various visibility and runway visual range (RVR) conditions, including fog and patchy fog effects; and (2) Effects on operating site lighting (including variable intensity and fog effects).		✓	✓			✓
13.3.2	The visual scene shall include the following: (1) Various visibility and runway visual range (RVR) conditions.	✓					✓
13.3.3	The visual scene shall permit gradual visibility changes entering and breaking out of the cloud for all times of day: (1) A realistic transition to IMC; and (2) A realistic transition to visual contact from IMC.	✓	✓	✓	4.e	4.e	✓

13: ATMOSPHERE AND WEATHER								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
13.3.4	The FSTD shall employ cloud layers representing few, scattered, broken and overcast conditions giving partial or complete obstruction of the ground scene.	✓	✓	✓			✓
13.3.5	For at least one cloud layer, it shall be possible to perceive and assess broken and scattered cloud thickness when looking at them from the outside. It shall be possible to enter broken and scattered clouds from the sides with appropriate transitions.			✓			✓
13.3.6	The clouds shall provide an in-cloud airspeed effect in the visual scene.			✓			✓
13.3.7	The clouds, fog and weather effects shall affect the ownship external lights (e.g. haze, reflection, etc.) in the visual scene.		✓	✓			✓
13.4	WEATHER EFFECTS Note: Visual representations of these are applicable only if a Visual Cueing feature is simulated and is at fidelity level G, R or S.						
13.4.1	The environment simulation shall include the following, with visual representations provided where applicable: (1) Rain; (2) Hail; (3) Storm cells; (4) Thunderstorms; (5) Falling snow; (6) Blowing snow; and (7) Blowing sand. The precipitation and blowing snow or sand shall be affected by the wind direction and velocity.			✓			✓
13.4.2	The FSTD shall provide special weather representations of light, medium, and heavy precipitation near a thunderstorm on take-off and during approach and landing. Representations need only be			✓			✓

13: ATMOSPHERE AND WEATHER								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
	presented at and below an altitude of 2,000 ft (610 m) above the airport surface and within 10 miles (16 km) of the airport.						
13.5	FOR AEROPLANES: WINDSHEAR AND MICROBURST						
13.5.1	The FSTD shall employ windshear models that provide training for recognition and necessary corrective pilot actions for the following critical phases of flight: (1) prior to take-off rotation; (2) at lift-off; (3) during initial climb; and (4) short final approach, below 500 feet AGL.		√	√	2.g		√
13.5.2	The Statement of Justification shall reference the windshear implementation method(s) used. Windshear 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. The United States Federal Aviation Administration (FAA) Windshear Training Aid, wind models from the Royal Aerospace Establishment (RAE), the United States JAWS Project or other recognised sources may be implemented and shall be supported and properly referenced in the Statement of Justification. Wind models from alternate sources may also be used if supported by aeroplane-related data and such data are properly supported and referenced. Use of alternate data shall be coordinated with the competent authority prior to submittal of the QTG for approval.		√	√	2.g		
13.5.3	The FSTD shall employ microburst models.			√			√
13.6	FOR ROTORCRAFT: WINDSHEAR AND MICROBURST						
13.6.1	The FSTD shall employ windshear models that provide training for recognition and necessary corrective pilot actions of windshear phenomena.			√			√

13: ATMOSPHERE AND WEATHER								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
13.6.2	The FSTD shall employ microburst models.			✓			✓
13.7	INSTRUCTOR CONTROLS - ENVIRONMENT						
13.7.1	The instructor controls shall be provided for: (1) Wind speed, direction and gusts; (2) Air temperature and its lapse rate; (3) Air pressure; (4) Turbulence levels; (5) Visibility (in kilometers or nautical miles) and runway visual range (in meters) if relevant, including fog and patchy fog effect; (6) Clouds layers with adjustable cloud types, bases, tops, sky coverage and scud effect; (7) Rain levels; (8) Storm cells; (9) Thunderstorms; and (10) Weather effects.		✓	✓			✓
13.7.2	The instructor controls shall be provided for: (1) Wind speed, direction and gusts; (2) Air temperature and its lapse rate; (3) Air pressure; (4) Turbulence levels; (5) Visibility (in kilometers or nautical miles) and runway visual range (in meters) if relevant; and (6) Cloud layers with adjustable cloud types, bases, tops, sky coverage.	✓					✓
13.7.3	The instructor controls shall be provided for: (1) Wake turbulence scenario with varying levels;			✓			✓

13: ATMOSPHERE AND WEATHER								
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION		
		G	R	S	QTG(A)	QTG(H)	F&S
	(2) Windshears models with varying degrees of severity; and (3) Microbursts. If a windshear or microburst model is not survivable it shall be labelled on the instructor operating station as unsurvivable.						
13.7.4	For aeroplanes: The instructor controls shall be provided for: (1) Windshears models with varying degrees of severity. If a windshear is not survivable it shall be labelled on the instructor operating station as unsurvivable.		√				√
13.7.5	The instructor controls shall be capable of: (1) To configure multiple cloud layers of different cloud types and coverage (2) To specify different wind speeds and directions at various altitudes from ground to high cruise altitudes. These cloud layers and wind conditions shall seamlessly blend to create a smooth and continuous atmospheric transition.	√	√	√			√
13.7.6	The Statement of Justification shall include a description of any additional atmospheric and weather effects that are simulated in excess to the required ones.	√	√	√			√

GM1 CS FSTD.QB.113 FSTD general requirements for Atmosphere And Weather

Summaries of the fidelity levels for the Atmosphere And Weather feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.113.

13: ATMOSPHERE AND WEATHER
Specific: Fully integrated dynamic environment simulation with weather effects. The environment is synchronised with other features. The visual weather presentation provides realistic cues for all weather conditions and effects, including precipitation, storms, windshears, and microbursts.
Representative: Fully integrated dynamic environment simulation with weather effects. The environment is synchronised with other features. The visual weather presentation provides realistic cues for visibility/RVR effects. Windshear simulation is provided for aeroplanes.
Generic: A basic atmospheric model. The environment is sufficient to permit accurate system operation and indications and is synchronised with appropriate features to provide integrity. The visual weather presentation provides transitions for entering and breaking out of clouds/IMC, as well as for visibility/RVR conditions.

GM2 CS FSTD.QB.113 Additional atmospheric and weather effects

The FSTD may also employ additional atmospheric and weather effects that are simulated in excess to the required ones. Such effects include but are not limited to:

(a) arctic sea smoke;

(b) katabatic winds;

(c) mountain waves and effects (rotors, demarcation lines, etc.);

(d) rig exhaust turbulence;

(e) wind masking due to buildings, trees, etc.; and

(f) turbulence and wind effects caused by topography and structures.

The Statement of Justification should include a description of any additional effects. See also CS FSTD.QB.017.

OPERATING SITES AND TERRAIN (OST)

CS FSTD.QB.114 FSTD general requirements for Operating Sites And Terrain (OST)

14: OPERATING SITES AND TERRAIN
Defines the complexity and level of detail of the operating sites (e.g. aerodrome, landing areas) and terrain modelling required to be simulated. This includes such items as generic versus customised operating sites (e.g. airport, heliport, vertiports, or other landing areas), visual scenes, terrain elevation. Since some aircraft types can land at a variety of different types of landing areas, often outside aerodromes and/or controlled airspace, the environment includes these types of landing areas in their visual scenes modelling. Note: The requirements shall be read in conjunction with CS FSTD.FST.020 and CS FSTD.FST.030 visual requirements (paragraph 13) to fully understand the details to be provided. Note: Requirements of this feature concerning the visual image are applicable only if a 'Visual Cueing' feature is at fidelity level G, R or S.

The general requirements for the Operating Sites And Terrain feature are presented in the table below.

14: OPERATING SITES AND TERRAIN						
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**	
		G	**R**	**S**	**QTG**	**F&S**
14.1	AIRPORT/LANDING AREA SCENES The following is the minimum airport/landing area model content requirement to satisfy visual capability tests and provide suitable visual cues to allow completion of all functions and subjective tests described in Subpart E. Note: Requirements in this section shall be demonstrated at a Class I operating site.					
14.1.1	There shall be multiple (at least three Class I) specific real-world 3D airport or heliport models to demonstrate the capabilities of the FSTD. They shall be among the same operating sites as simulated in accordance with the navigation feature.			✓		✓

14: OPERATING SITES AND TERRAIN						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
14.1.2	Where an aircraft can land at a variety of different types of landing areas, including those outside aerodromes and/or controlled airspace, the environment shall include these types of landing areas in their visual scenes modelling.		√	√		√
14.1.3	Airport, helipad and/or heliport models shall have realistic terrain modelling, runway orientation, markings, lighting, dimensions and taxiways. The visual model shall be correctly aligned (e.g. navigation aids, runways, gates, terrain, buildings).			√		√
14.1.4	At least one airport/landing area scene shall include functionality to support ground manoeuvring, e.g. low visibility taxi route with marker boards, stop bars, runway guard lights plus the required approach and runway lighting, centerline lights, lead on and lead off.			√		√
14.1.5	The displayed scene shall correspond to the appropriate surface contaminants and include runway lighting reflections for wet, partially obscured lights for snow, or suitable alternative effects. For wet and patchy wet airport contaminants, some other non-lighting object reflections shall also be included (such as, but not specifically required nor limited to, terminal building, lamp posts, jetways, aircrafts, vehicles, etc.).			√		√
14.1.6	The system shall provide visual effects for: (1) light poles; (2) raised runway edge lights as appropriate; and (3) glow associated with approach lights in low visibility before physical lights are seen; and (4) glow associated with airport illumination (lamp posts and others) in low visibility.			√		√
14.1.7	For airport, helipad and/or heliport: Correct terrain modelling, runway orientation, markings, lighting, dimensions and taxiways.			√		√

14: OPERATING SITES AND TERRAIN						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
14.1.8	For rotorcraft: There must be at least three non-airport landing areas, as follows: (1) at least one aircraft landing area situated on a substantially elevated surface with respect to the surrounding structures or terrain (e.g. building top, offshore oil rig); (2) at least one aircraft landing area that meets the definition of a 'confined landing area'; and (3) at least one aircraft landing area on a sloped surface where the slope is at least 2.5°.		√	√		√
14.1.9	For rotorcraft: There shall be a sloped landing area which supports different slopes up to the maximum permitted slope.		√	√		√
14.1.10	For rotorcraft: A generic slope landing area shall be provided.	√				√
14.1.11	The runway or landing site shall be identifiable from the downwind leg, or approach direction at all times of day. Airport, heliport, or landing site lights shall be representative of the airport/heliport/site modelled. For example runway edge lights shall be bi-directional or omni-directional to enable visual approaches and visual circuits.		√	√		√
14.1.12	For aeroplanes: At least one fully customised 3D airport model. It shall be among the same operating sites as simulated in accordance with the navigation feature.		√			√
14.1.13	For rotorcraft: A minimum of one airport or heliport and one aircraft landing area model. At least one fully customised 3D airport/heliport model. It shall be among the same operating sites as simulated in accordance with the navigation feature.		√			√

14: OPERATING SITES AND TERRAIN						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
14.1.14	The airport, heliport or aircraft landing area(s) may be either fictional or real-world. They shall be among the same operating sites as simulated in accordance with the navigation feature.		√			√
14.1.15	For rotorcraft: The airport or heliport and the aircraft landing area may be contained within the same model. If this option is selected, the approach path to the airport runway(s) and the approach path to the aircraft landing area must be different.		√			√
14.1.16	The fidelity of the visual scene must be sufficient for the aircrew to visually identify the airport and/or rotorcraft landing area; determine the position of the simulated aircraft within the visual scene; successfully accomplish take-offs, approaches, and landings; and manoeuvre around the airport on the ground, or in hover taxi, as necessary.		√			√
14.1.17	The airport visual scene shall be representative of a typical airfield or landing site, including terrain surface (grass, tarmac) and characteristics (soft, hard, slippery) but not necessarily geo-specific. Highly detailed and accurate surface depiction of the terrain surface within an approximate area from 400 m (1/4 sm) before to 400 m (1/4 sm) beyond the runway approach end with a total width of approximately 400 m (1/4 sm) including the width of the runway.		√			√
14.1.18	Ground objects shall be presented in sufficient quantity to permit orientation and alignment for ground reference manoeuvring (i.e. traffic pattern and/or high/low reconnaissance), hovering and taxiing. All ground objects must be presented in proper size and perspective, presenting no distraction to the pilot.		√			√
14.1.19	The system shall include a generic airport model with an aircraft landing area available that is operable at the same operating sites as the simulation of the airports of the Navigation feature.	√				√

14: OPERATING SITES AND TERRAIN						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
14.1.20	Generic airport/heliport model(s) with terrain topographical features: (1) Shall have a visible horizon; and (2) Shall include runway and taxiway markings and lighting.	✓				✓
14.1.21	All the available operating sites shall be classified as Class I, II or III in accordance with CS FSTD.QB.114.1.	✓	✓	✓		
14.2	GEOGRAPHIC AREA					
14.2.1	Terrain shall have visual texturing to give sufficient cues to permit pilots to determine speed, altitude and position information.	✓	✓	✓		✓
14.2.2	Geo-specific scene content and terrain: Colours and textures shall represent a particular geographic area environment as appropriate to the location of the operating site, e.g. vegetation, landscape, desert, arctic, jungle. Ground objects shall be presented in sufficient quantity and quality to permit orientation and alignment for ground reference manoeuvring (i.e. traffic pattern and or high/low reconnaissance).		✓	✓		✓
14.2.3	For rotorcraft: The following effects shall be displayed as a function of wind and downwash: (1) Movement of trees in confined area landing sites; and (2) Movement of grass.			✓		✓
14.2.4	Integration of the aircraft systems and the visual terrain model: If an aircraft system provides information on the terrain (e.g. radio altimeter, EGPWS, HTAWS, synthetic vision system, radar, forward looking IR camera, etc.), the visual image shall correspond to the information provided by the system (e.g. topography, obstacles, etc.).		✓	✓		✓

14: OPERATING SITES AND TERRAIN						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
14.2.5	Geo-specific scene content and terrain: to include topographical information, such as buildings, trees, obstacles (as well as other features, such as unprepared landing sites, confined areas, ships, rigs, if required) that allows VFR navigation training.		✓			✓
14.2.6	Generic texture and ground objects are acceptable. The terrain may be flat. Terrain does not need to represent any geo-specific location.	✓				✓
14.2.7	The FSTD shall provide operational visual scenes that portray physical relationships known to cause landing illusions to pilots. For example: short runways, landing approaches over water, uphill or downhill runways, rising terrain on the approach path, and unique topographic features.		✓	✓		✓
14.2.8	The airport visual scene shall be representative of a typical airfield or landing site, including terrain surface (grass, tarmac) and characteristics (soft, hard, slippery) but not necessarily geo-specific.		✓			✓
14.2.9	Daylight visual scenes shall have sufficient scene content to recognize the airport, the terrain, and major landmarks around the airport. Landmarks include features such as roads, rivers and fields, as well as significant identifiable buildings. Where 3D models are included, these shall be representative. The scene content must allow a pilot to successfully accomplish a visual landing.		✓	✓		✓
14.2.10	For rotorcraft: Daylight, twilight and night visual scenes with the capability to display sufficient scene content to recognize generic aerodromes, heliports, terrain and landmarks around the Final Approach and Take-off (FATO) area and to accomplish low airspeed/low altitude manoeuvres to include lift-off, hover, translation to and from the hover into forward flight, landing and touchdown adequate for instrument training.	✓				✓

14: OPERATING SITES AND TERRAIN						
FEATURE GENERAL REQUIREMENTS		**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**	
		G	**R**	**S**	**QTG**	**F&S**
14.2.11	Twilight Visual Scenes shall have sufficient scene content to recognize the airport, the terrain, and major landmarks around the airport. The scene content must allow a pilot to successfully accomplish a visual landing. Twilight scenes, as a minimum, must provide full colour presentations of reduced ambient intensity, sufficient surfaces with appropriate textual cues that include self-illuminated objects such as road networks, ramp lighting and airport signage, to conduct a visual approach, landing and airport movement (taxi).		✓	✓		✓
14.2.12	Night visual scenes shall have sufficient content to recognize the airport, the terrain, and major landmarks around the airport. The scene content must allow a pilot to successfully accomplish a visual landing.		✓	✓		✓
14.2.13	Night scene shall include stars, ground lights, and sufficient texture to clearly identify the aircraft attitude and differentiate between the terrain and sky.	✓	✓	✓		✓
14.2.14	The visual system shall have airborne and ground traffic capability.		✓	✓		✓
14.3	AERODROME (e.g. AIRPORT, HELIPORT) CURRENCY					
14.3.1	Specific aerodromes, airports, or heliports modelled in the system shall be able to be updated and maintained.			✓		✓
14.3.2	The specific airport or heliport modelled in the system shall be maintained current with the state of the corresponding real-world airport or heliport as identified in the airport or heliport charts.			✓		✓
14.4	VISUAL SCENE FOR ROTORCRAFT DEVICES WITH VISUAL CUE FEATURE AT GENERIC FIDELITY LEVEL					
14.4.1	The system shall provide a visual scene with sufficient scene content to allow a pilot to successfully accomplish a visual landing. Scenes shall include a definable horizon and typical terrain characteristics such as fields, roads and bodies of water and surfaces illuminated by rotorcraft landing lights.	✓				✓

14: OPERATING SITES AND TERRAIN							
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
14.4.2	Airport model may be generic (no specific topographical features required).	✓				✓
14.5	LOW-VISIBILITY OPERATIONS					
14.5.1	The system shall include at least one airport scene with low-visibility details and functionality e.g. low-visibility taxi route with marker boards, stop bars, runway guard lights plus the required approach and runway lighting.			✓		✓
14.5.2	There shall be at least one airport scene with functionality to support the approach to the lowest minima applicable to the simulated aircraft type and as stated in the ESL. This airport scene shall support for example low visibility taxi routes with marker boards, stop bars, runway guard lights plus the required approach, runway and taxiway lighting.		✓			✓
14.6	VISUAL FEATURE RECOGNITION					
14.6.1	The following visual scene features shall be recognisable at an appropriate distance depending on the time of day (day, twilight, night): (1) Surface resolution and runway lighting (2) Taxiways (day), taxiway lighting (twilight/night) (3) Approach and airfield lighting	✓	✓	✓		✓
14.6.2	Scenes shall include a definable horizon and typical terrain characteristics such as fields, roads and bodies of water. If provided, the directional light seen at the horizon must have correct orientation and be consistent with surface shading effects.			✓		✓
14.6.3	Surfaces on the ground that are in range of the aircraft or external lighting shall be appropriately illuminated.			✓		✓

14: OPERATING SITES AND TERRAIN						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
14.6.4	All ground objects must be presented in proper size and perspective, presenting no distraction to the pilot. In good visibility, the horizon shall be sufficiently visible to determine the aircraft attitude. Day or night horizon representation can be obscured by multiple ragged or solid cloud layers adjustable for bottom and top layers corresponding to the aircraft altitude.			√		√
14.6.5	Highly detailed and accurate surface depiction of the terrain surface within an area sufficient to achieve cross-country flying under VFR conditions.			√		√
14.6.6	Terrain surface references and topographical features shall be adequate to navigate using appropriate charts (typically 1:500 000, 1:250 000, 1:100 000 scale mapping).			√		√
14.6.7	In good visibility, the horizon shall be sufficiently visible to determine the aircraft attitude. The day or night horizon representation can be obscured by multiple ragged or solid cloud layers adjustable for bottom and top of cloud layer corresponding to the aircraft altitude.		√			√
14.6.8	Terrain surface references and topographical features shall be sufficient to support VFR navigation according to appropriate charts (typically 1:500 000, 1:250 000, 1:100 000 scale mapping).		√			√
14.6.9	In good visibility, the horizon shall be sufficiently visible to determine the aircraft attitude. The day or night horizon representation can be obscured by a solid cloud layer adjustable for bottom and top of the cloud layer corresponding to the aircraft altitude.	√				√
14.6.10	Daylight scenes shall include sky and terrain suitably coloured and textured to clearly identify aircraft attitude.	√				√
14.7	SEA STATE					
14.7.1	For aeroplanes if required for training: 3D sea states that can be controlled by the instructor, shall be included.		√	√		√

14: OPERATING SITES AND TERRAIN						
FEATURE GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
14.7.2	For rotorcraft: The following effects shall be capable of being displayed (as applicable): (1) sea states corresponding to the wind conditions selected on the IOS, including the resulting movement of ships used for deck landings; (2) effects of wind lanes on water surface; and (3) marine vessel movement shall at least conform to the sea state in pitch, roll and heave.		✓	✓		✓
14.8	DOWNWASH EFFECTS FOR ROTORCRAFT					
14.8.1	The effects of ownship downwash upon various surfaces such as snow, sand, water and grass shall be simulated including associated effects of reduced visibility due to recirculation (e.g. brownout due to sand, whiteout due to snow).		✓	✓		✓
14.9	INSTRUCTOR CONTROLS - OPERATING SITES					
14.9.1	The FSTD shall have instructor controls for the following: (1) Airport selection; (2) Airport lighting; (3) Runway conditions (e.g. friction or braking action); and (4) Surface contaminants for the runways, taxiways and apron or operating site.	✓	✓	✓		✓

GM1 CS FSTD.QB.114 FSTD general requirements for Operating Sites And Terrain

Summaries of the fidelity levels for the Operating Sites And Terrain feature are presented in the table below. These summaries are only broad overviews provided for guidance only. They do not encompass all aspects and requirements and are not intended to replace CS FSTD.QB.114.

14: OPERATING SITES AND TERRAIN
Specific: A selection of specific real-world 3D airport or heliport models with accurate terrain modelling, runway markings, and lighting. The visual scene colours and textures represent a particular geographic area. Major landmarks around the airport are present, and ground objects are realistically sized. Highly detailed and accurate surface depiction of the terrain surface within an area sufficient to achieve cross-country flying under VFR conditions. For rotorcraft, the FSTD simulates the effects of ownship downwash on various surfaces. The visual scene corresponds to actual surface conditions.
Representative: At least one fully customised 3D airport model that may be either fictional or real-world. The visual scene colours and textures represent a particular geographic area. Major landmarks around the airport are present. Terrain surface references and topographical features are sufficient to support VFR navigation according to VFR charts. For rotorcraft, the FSTD simulates the effects of ownship downwash on various surfaces.
Generic: Fictional or real world operating site model(s) with generic scene content, topographical features, orientation, markings, lighting, dimensions and taxi routes for aircraft ground operations including take-off and landing. Terrain does not need to represent any geo-specific location and may be flat. Visual texturing gives sufficient cues to permit pilots to determine speed, altitude and position information.

CS FSTD.QB.114.1 Visual scene operating sites

(a) Applicability

(1) This CS applies to all Operating Sites used on FSTD Visual Databases.

(2) Operating Site is a term used to include Visual System models of Aerodromes, which includes Landing Areas (for rotorcraft), Airport Models etc.

(b) Operating Site Classifications

(1) Airport Models

(I) Class I. Whether modelling real world or fictional airports (or landing areas for rotorcraft), these operating sites are those that meet the requirements of the

Operating Sites And Terrain feature in CS FSTD.QB.114. These models are intended for demonstration of the capabilities of the FSTD.

(II) Class II. Whether modelling real world or fictional airports (or landing areas for rotorcraft), these operating sites are those models that are in excess of those used for FSTD qualification. These models are specific or customised models that are maintained by the FSTD operator for use in training.

(III) Class III. This is a special class of operating site (or landing area for rotorcraft), used for specific purposes, and includes models that may be incomplete or inaccurate when viewed without restriction, but when appropriate limits are applied (e.g., 'valid for use only in visibility conditions less than 1 kilometre or RVR 1000 m', 'valid for use only for approaches to Runway 22L and 22R'), those aspects that may be incomplete or inaccurate may not be able to be recognized as such by the crew member(s). Use of Class III airport models requires the FSTD operator to submit to the competent authority an appropriate analysis of the skills, knowledge, and abilities necessary for competent performance of the task(s) in which this particular model is to be used.

(2) The organisation requesting qualification of an FSTD shall deliver a list of all the Class I, II and III Operating Sites to the competent authority prior to the initial evaluation.

MISCELLANEOUS

CS FSTD.QB.115 FSTD miscellaneous general requirements

MISCELLANEOUS
The requirements contained within this section are applicable to all FSTDs and are not related to any feature fidelity levels.

Miscellaneous general requirements are presented in the table below.

15: MISCELLANEOUS				
GENERAL REQUIREMENTS		**VERIFICATION & VALIDATION**		
		QTG(A)	**QTG(H)**	**F&S**
15.1	INSTRUCTOR OPERATING STATION The overall requirements for the FSTD's instructor operating station are described here. The IOS shall support the use of the FSTD to meet all the other requirements.			
15.1.1	The instructor station shall be on-board, or in the immediate proximity of the flight deck and have a direct, unobstructed, view of the flight deck area. The location of the instructor station shall provide an adequate view of the pilots' panels and forward windows.			✓
15.1.2	An instructor's station with a seat shall be provided.			✓
15.1.3	The instructor operating station (IOS) shall not distract the instructor from observing the activities of the flight crew.			✓
15.1.4	The view for the observer may be a direct view to the visual system and flight deck provided that the observer has an adequate out-of-the-window view without interfering with, nor distracting, the instructor.			✓
15.1.5	The FSTD shall have motion and control loading emergency stop controls accessible from pilot and instructor seats.			✓

15: MISCELLANEOUS				
GENERAL REQUIREMENTS		VERIFICATION & VALIDATION		
		QTG(A)	QTG(H)	F&S
15.2	INSTRUCTOR CONTROLS Describes the controls that are required for the instructor during the use of the FSTD.			
15.2.1	Instructor controls shall be provided for all appropriate system variables, freezes, resets and for insertion of malfunctions to simulate abnormal and emergency conditions. The available malfunctions shall be relevant for training.			✓
15.3	UPSET PREVENTION AND RECOVERY TRAINING Applicable to aeroplane FSTDs to be qualified for upset prevention and recovery training (UPRT).			
15.3.1	The FSTD must have a real-time feedback tool that provides the instructor/evaluator with visibility whenever the FSTD training envelope or aeroplane operating limits have been exceeded. The feedback tool shall include the following: (1) FSTD validation envelope: This must be in the 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. (2) 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). (3) Aeroplane operational limits: This must display the aeroplane's operational limits during the manoeuvre as applicable for the configuration of the aeroplane. A Statement of Justification shall define the source data used to construct the FSTD validation envelope. Refer to CS FSTD.QB.125 and GM1 CS FSTD.QB.125.			✓
15.3.2	The FSTD shall have an optional recording mechanism that may be utilised, that is triggered and displayed on the instructor station.			✓

15: MISCELLANEOUS				
GENERAL REQUIREMENTS		VERIFICATION & VALIDATION		
		QTG(A)	QTG(H)	F&S
15.3.3	The FSTD shall have upset scenarios, where dynamic upset scenarios, or aeroplane system malfunctions are used to drive the FSTD into an upset condition.			√
15.3.4	Upset scenarios: When equipped with IOS selectable 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. (a) 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. (b) Consideration shall be given to flight-envelope-protected aeroplanes as artificially positioning the aeroplane to a specified attitude may incorrectly initialise flight control laws.			√
15.3.5	Each upset prevention and recovery feature programmed at the IOS and the associated training manoeuvre shall be evaluated by a suitably qualified pilot. (a) A suitably qualified pilot shall: (1) hold a type rating qualification for the aeroplane being simulated; and (2) be familiar with the upset scenarios and associated recovery methods as well as the cues necessary to accomplish the required training objectives; (b) The Statement of Justification shall 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.			√
15.4	INSTRUCTOR AND OBSERVER SEATING Describes the controls that are required for the instructor during the use of the FSTD.			

15: MISCELLANEOUS				
GENERAL REQUIREMENTS		VERIFICATION & VALIDATION		
		QTG(A)	QTG(H)	F&S
15.4.1	The instructor and observer's seats need not represent those found in the aircraft. All three seats shall be of adequate comfort for the occupant to remain seated for typical training session durations. Seat for instructor and at least two seats for inspectors/observers shall also be provided. For an FSTD with a motion cueing system, any on board instructor/observer seat(s) shall be adequately secured and fitted with positive restraint devices of sufficient integrity to safely restrain the occupant during any known or predicted motion system excursion.			✓
15.4.2	Both observer seats shall have adequate lighting to permit note taking.			✓
15.4.3	At least one observer seat shall have the capability to monitor flight crew actions (i.e. have an adequate view of the flight deck) and flight crew / instructor communications.			✓
15.5	COMPUTER CAPACITY			
15.5.1	Sufficient FSTD computer capacity, accuracy, resolution, and dynamic response shall be provided to fully support the overall FSTD fidelity needed to meet the FCS sought.			
15.6	SELF-DIAGNOSTIC TESTING			
15.6.1	Self-diagnostic testing of FSTD shall be available to determine the integrity of hardware and software operation and to provide a means for quickly and effectively conducting daily testing of the FSTD software and hardware.			
15.7	AUTOMATIC TESTING FACILITIES			
15.7.1	Automatic objective testing of FSTD hardware and software to determine compliance with the objective test requirements and to enable recurrent testing shall be available.			
15.8	UPDATES TO FSTD HARDWARE AND SOFTWARE			
15.8.1	The FSTD architecture shall support updates of FSTD hardware and software and enable usage of different software loads (i.e. separation of current accepted load used for training, test or development load and old loads).			

15: MISCELLANEOUS				
GENERAL REQUIREMENTS		VERIFICATION & VALIDATION		
		QTG(A)	QTG(H)	F&S
15.9	SYSTEM INTEGRATION			
15.9.1	Relative response of the visual system (where fitted), flight deck instruments and initial motion system shall be coupled closely to provide integrated sensory cues.	6.a	6.a	√
15.9.2	The motion response shall occur before the visual response.	6.a	6.a	√
15.9.3	Additional transport delay test results are required where HUD/EFVS systems are installed, which are simulated and not actual aircraft systems.	6.a	6.a	√
15.9.4	Where a visual system's mode of operation (daylight, twilight, and night) can affect performance, additional tests are required. In such cases, the Statement of Justification shall justify this.	6.a	6.a	√
15.10	XR SYSTEMS: SYSTEM INTEGRATION Note: Requirements marked with √[1] indicate that an objective test section for these is not available. The tests shall be defined in the Special Conditions.			
15.10.1	The tracking delay shall be minimised. Tracking delay refers to the entire process (i.e. movement - image generation - graphic processing unit - headset).	√[1]	√[1]	√
15.11	XR SYSTEMS: VR DISPLAY - INSTRUCTOR SYSTEM REQUIREMENTS			
15.11.1	The view of the crew member(s) HMD image shall be presented on the IOS at all times.			√
15.11.2	It shall be possible for the instructor to see the body pose (representation) of the crew member(s) in the virtual environment.			√
15.12	XR SYSTEMS: CLIMATE REQUIREMENTS			
15.12.1	For cyber sickness prevention and training comfort, the room climate shall be controlled. Sufficient fresh air, appropriate room temperature and appropriate CO2 level shall be ensured.			√

CS FSTD.QB.120 MCC requirements for FSTDs

For multi-crew co-operation (MCC) training and operation, the minimum systems, instrumentation and indicators shall be installed and simulated as applicable for the simulated aircraft at the levels of features Flight Deck Layout And Structure and Aircraft Systems:

(a) For aeroplane FSTDs:

(1) Turbojet or turbo-prop engine;

(2) Performance reserves, in the case of an engine failure, to be in accordance with aircraft certification requirements (e.g. CS-25);

(3) Retractable landing gear;

(4) Pressurisation system;

(5) De-icing systems;

(6) Fire detection / suppression system;

(7) Dual controls;

(8) Autopilot with automatic approach mode;

(9) Two VHF transceivers including oxygen masks intercom system;

(10) Two VHF NAV receivers (VOR, ILS, DME);

(11) One GNSS system;

(12) One ADF receiver (as applicable to aircraft simulated);

(13) One Marker receiver;

(14) One transponder.

(15) The following indicators shall be in the same positions on the instrument panels of both pilots (as applicable for the simulated aircraft):

(i) Airspeed;

(ii) Flight attitude with flight director;

(iii) Altimeter;

(iv) Flight director with ILS (HSI);

(v) Vertical speed;

(vi) ADF (as applicable to aircraft simulated);

(vii) VOR, ILS, DME;

(viii) Marker indication (as appropriate);

(ix) Stopwatch.

(b) For rotorcraft/helicopter FSTDs:

(1) Multi-engine and multi-pilot aircraft;

(2) Performance reserves, in case of an engine failure, to be in accordance with Category A criteria;

(3) Anti-icing or de-icing systems;

(4) Fire detection / suppression system;

(5) Dual controls;

(6) Autopilot with upper modes;

(7) Two VHF transceivers;

(8) Two VHF NAV receivers (VOR, ILS, DME);

(9) One GNSS system;

(10) One ADF receiver (as applicable to aircraft simulated);

(11) One Marker receiver;

(12) One transponder;

(13) Weather radar.

(14) The following indicators shall be in the same positions on the instrument panels of both pilots (as applicable for the simulated aircraft):

(i) Airspeed;

(ii) Flight attitude;

(iii) Altimeter and radio altimeter;

(iv) HSI;

(v) Vertical speed;

(vi) ADF (as applicable to aircraft simulated);

(vii) VOR, ILS, DME;

(viii) Marker indication (as appropriate);

(ix) Stopwatch.

CS FSTD.QB.125 FSTD standards to support UPRT feedback tools

(a) Applicability

(1) This CS applies to all FTSDs that are used to satisfy training provisions for UPRT manoeuvres. For the purposes of this CS, an aeroplane upset is an undesired aeroplane state characterised by unintentional deviations from parameters experienced during normal operations. An aeroplane upset may involve pitch or bank angle deviations as well as inappropriate airspeeds for the given conditions.

(b) FSTD Standards

(2) FSTD standards provisions

(i) The provisions of this CS define three basic elements that are required for qualifying an FSTD for UPRT manoeuvres:

(A) FSTD training envelope: see definition in CS FSTD.GEN.015;

(B) 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

(C) upset scenarios: where dynamic upset scenarios or aeroplane system malfunctions are used to drive the FSTD into an aeroplane upset condition, specific guidance shall 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.

(ii) FSTD validation envelope; This envelope is defined by the following three subdivisions.

(A) 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 the 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. 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.

(B) Wind tunnel 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 'characteristic' stall model (as described in CS FSTD.QB.107.3.STALL) shall be clearly indicated. Within this region, there is moderate confidence that the FSTD will respond in a similar way as the aeroplane.

(C) 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 shall 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 shall be available to the instructor/evaluator:

(I) FSTD validation envelope

The FSTD shall 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 shall display the relevant validity regions for flaps-up and flaps-down at a minimum. This validation envelope shall 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 shall employ a method for the instructor/evaluator to assess the trainee's flight control inputs during the upset recovery manoeuvre. Additional parameters, such as flight deck control forces (forces applied by the pilot to the controls) and the flight control law mode for fly-by-wire aeroplanes, shall 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 shall include a time history or other equivalent method of recording flight control positions.

(III) Aeroplane operational limits

The FSTD shall employ a method to provide the instructor/evaluator with real-time information concerning the aeroplane operational limits. The simulated aeroplane's parameters shall be displayed dynamically in real time and provided in a time-history or equivalent format. At a minimum, the following parameters shall 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 (refer to CS FSTD.QB.107.3.STALL 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.

GM1 CS FSTD.QB.125 FSTD standards to support UPRT feedback tools

(a) Introduction

A Statement of Justification should provide information pertaining to the aeroplane's parameters as described in CS FSTD.QB.115. This GM details some of the provisions for these.

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

(c) 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 (refer to CS FSTD.QB.125), and take any necessary action to complete the training.

(d) 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.

(e) IOS parameters

The tool should normally display the following:

(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 flight deck 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 pseudo primary flight display (PFD); if a pseudo PFD is displayed, then the parameters should 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.

One method to show the limitations of (3) and (4) is through the simultaneous depiction of the angle of attack versus angle of sideslip and the corresponding FSTD validation envelope.

The V-n diagram is a method to show the aeroplane load factor during a flight manoeuvre relative to its operational load factor and airspeed limits. The diagram boundaries indicate the aeroplane operational flight envelope and it presents the G-loading with the current airspeed and flight configuration. The lower airspeed limit line represents the stall speeds governed by the aerodynamic characteristics. The maximum airspeed limit line represents the operational limit airspeeds (such as maximum operating airspeed (VMO), maximum operating Mach (MMO), never exceed speed (VNE), maximum flap operating airspeed (VFE), or maximum gear operating airspeed (VLO)). The upper and lower lines represent the operational load factor limits. The displayed data should be in accordance with the aircraft OEM operating recommendations and limitations. The shape and limits of the V-n diagram depend on the aircraft, its configuration, as well as the environmental and flight conditions.

The V-n diagram's shape varies also as a function of Mach number and other parameters. For example, for a transport category jet aircraft, the lower airspeed limits may be very different for stall events at nominal cruise altitudes and low altitudes in cruise configuration. If the V-n diagram does not consider such aspects, the IOS should show a distinct label to indicate it.

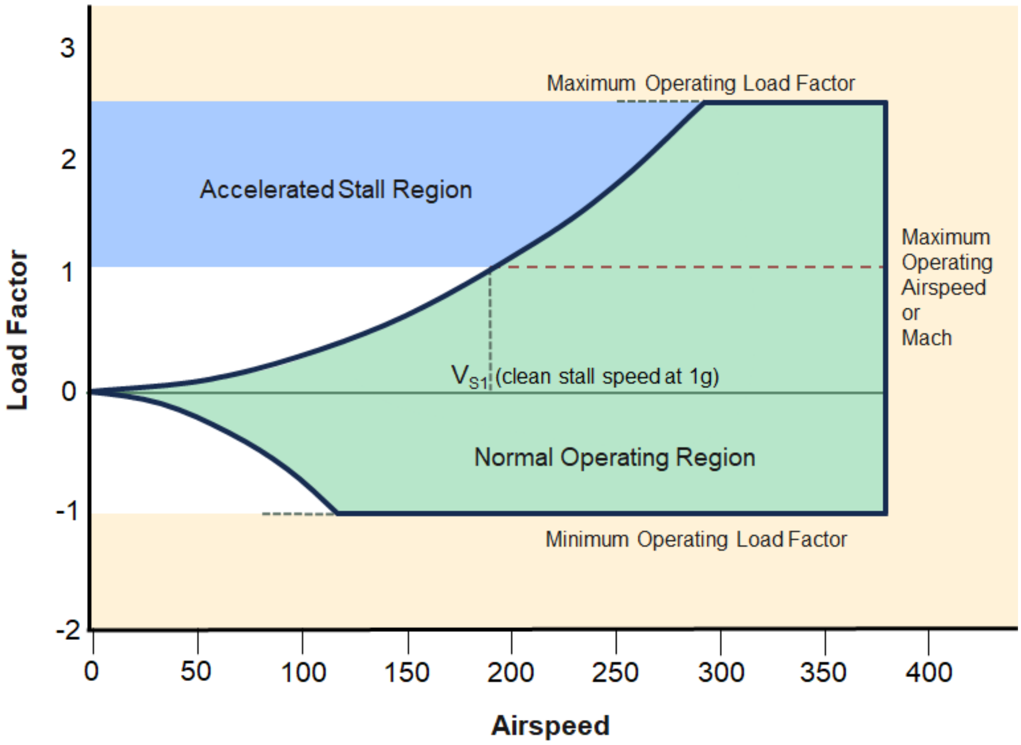

Figure 1: V-n diagram (example)

CS FSTD.QB.130 Head-up display (HUD) requirements for FSTDs

(a) Applicability

(1) This CS applies to all FSTDs with a head-up display (HUD) installation at Specific and Representative fidelity levels. While the requirements in this CS concern many features, they are given here as a single entity.

(2) For the purposes of this CS, 'HUD' will be used as a general term for any alternative aircraft instrument system which displays information to a pilot through a combiner glass in the normal 'out-the-window' view.

(3)

(4) Objective tests for new, modified, or upgraded FSTDs incorporating a HUD system shall contain a SOJ. The SOJ shall be an attestation that HUD hardware and software, including associated displays, function the same way as the HUD installed in the aircraft. A block diagram describing the input and output signal flow and comparing it to the aircraft configuration shall support this SOJ.

(b) FSTD HUD standards

(1) For a HUD system at Specific fidelity level, the display equipment shall be provided as fitted in the aircraft flight deck.

(2) For a HUD system at Representative fidelity level, the display equipment shall be provided as fitted in the aircraft flight deck, or the data may be displayed on the out of the window display. Where data are displayed outside the flight deck such as

overlaid on the visual image, the data image shall be controllable by the pilot as it is on the aircraft, and would only be applicable to single pilot operations.

(3) For non-collimated systems, only one display can be used by the pilot flying due to alignment with the out of the window displays.

(4) Whether the HUD system is an actual aircraft system or is software-simulated, the system shall be shown to perform its intended function for each operation and phase of flight.

(5) An active display (repeater) of all parameters displayed on the pilot's combiner shall be located on the instructor operating station (IOS), or at another location approved by the competent authority. Display format of the repeater shall replicate that of the combiner.

(c) Objective testing

(1) The HUD attitude shall align with the ownship attitude. Static calibration tests shall be included for HUD attitude alignment in the QTG. These tests may be combined with the alignment tests for the FSTD visual system. Refer to Subpart D objective test section 4.b.

(2) HUD systems that are software-simulated (not being an actual aircraft system) shall include latency/throughput tests in all three axes. The HUD system display shall be within 100 ms of the control input. Refer to Subpart D objective test section 6.a for instrument system response time.

(d) Subjective testing

(1) The ground and flight tests that shall be conducted for the qualification of HUD systems are listed below and may be combined with subjective manoeuvres not dedicated to HUD testing. Only those phases of flight for which the particular HUD system is authorised shall be tested and detailed in the QTG. The testing shall be conducted using daylight, dusk and night conditions as available or applicable:

(i) pre-flight inspection of the HUD system;

(ii) taxi:

(A) HUD taxi guidance;

(B) combiner horizon matches the visual horizon within the manufacturer’s tolerance;

(2) take-off:

(i) normal take-off in visual meteorological conditions (centreline guidance if available);

(ii) instrument take-off using the lowest RVR authorised for the particular HUD;

(iii) engine-out take-off;

(iv) maximum demonstrated crosswind take-off;

(v) windshear during take-off;

(3) in-flight:

(i) climb;

(ii) turns;

(iii) cruise;

(iv) descent;

(4) approaches:

(i) normal approach in visual meteorological conditions;

(ii) ILS approach with a crosswind:

(A) flight path vector shall represent the inertial path of the aircraft;

(B) course indication matches the track over the ground;

(C) HUD combiner shall not excessively degrade the approach lights;

(iii) engine-out approach and landing;

(iv) non-precision approach;

(v) circling approach, if applicable;

(vi) missed approach — normal and engine-out;

(vii) maximum demonstrated crosswind approach and landing;

(viii) windshear on approach;

(5) malfunctions:

(i) malfunctions causing abnormal pre-flight tests;

(ii) malfunctions logically associated with training during take-off and approach; and

(iii) malfunctions associated with any approved flight manual abnormal procedures which are not included above.

(e) Some real HUD systems have been certified without emergency power backup. Therefore, they will blank out and effectively reboot if any temporary power loss occurs. This shall be confirmed by checking the manufacturer's data and the simulated HUD system shall operate accordingly.

CS FSTD.QB.135 Enhanced flight vision system (EFVS) requirements for FSTDs

(a) Applicability

(1) This CS applies to all FSTDs with an enhanced flight vision system (EFVS) installations at Specific and Representative fidelity levels and is in addition to the head-up display (HUD) requirements detailed in CS FSTD.QB.115.HUD. While the requirements in this CS concern many features, they are given here as a single entity.

(2) For the purposes of this CS, 'EFVS' will be used as a general term for any alternative aircraft visual enhancement aid using imaging sensors, such as an infrared radiometer

or a radar, which displays information to a pilot through a HUD combiner glass in the normal 'out-the-window' view.

(3) Objective tests for FSTDs incorporating an EFVS system shall contain a SOJ. The SOJ shall be an attestation that the EFVS hardware and software, including associated displays and annunciation, function in the same way or in an equivalent way to the EFVS system(s) installed in the aircraft. A block diagram describing the input and output signal flow and comparing it to the aircraft configuration shall support this SOJ.

(b) FSTD EFVS standards

(1) Whether the EFVS system is an actual aircraft system or is software-simulated, the system shall be shown to perform its intended function for each operation and phase of flight.

(2) The minimum FSTD requirements for qualifying an EFVS system in an FSTD to Specific or Representative fidelity level are:

(i) the EFVS FSTD hardware and software, including associated flight deck displays and annunciation, shall function the same or in an equivalent way to the EFVS installed in the aircraft;

(ii) an active display (repeater) of the pilot's combiner shall be located on the IOS, or at another location approved by the competent authority. It shall include a duplicate display of the EFVS and HUD scene, as seen through the pilot's HUD combiner glass or the flight deck flight displays;

(iii) for aircraft where the EFVS image presentation is combined with the HUD, the repeated HUD image on the IOS shall also include the EFVS image with correct registration;

(iv) IOS weather pre-sets shall be provided for EFVS minimums; and

(v) a minimum of one airport/operating site shall be modelled for EFVS operation. That model shall have an ILS and a non-precision approach (with VNAV if required by the aircraft flight manual for the simulated aircraft type) available. In addition to EFVS modelling, the airport model shall meet the applicable visual system requirements in the Operating Sites And Terrain CS FSTD.QB.114 general requirements.

(c) Objective testing

Refer to Subpart D objective test section 4.c.

(d) Subjective testing

(1) Handling qualities, performance, and FSTD systems operation, while using the EFVS system, shall be subjectively assessed.

(2) The ground and flight tests and other checks required for qualification of the EFVS system are listed below. They include manoeuvres and procedures to assure that the EFVS system functions and performs appropriately for use in pilot training and checking in the manoeuvres and procedures, including any OSD Special Emphasis Items, or items delineated in the relevant JOEB or EASA OEB reports. The testing shall be conducted using daylight, twilight, and night conditions:

(i) IOS: Check to ensure that the IOS has preset selections that match the training programme.Pre-flight:

(A) Carry out normal pre-flight procedures and checks, including warnings and annunciations.

(ii) Taxi:

(A) Observe parallax caused by sensor position.

(B) Observe ground hazards, especially other aircraft and nearby terrain.

(C) Signs may appear as a block (unreadable) due to the absence of temperature variation between the letters and the background, with an infrared sensor.

(iii) Take-off:

(A) Normal take-off in night VMC conditions. Observe the terrain and surrounding visual scene.

(B) Instrument take-off using visual RVR settings of 180 m. The EFVS RVR shall be better than the visual RVR, i.e. 750 m+.

(iv) In-flight operations:

(A) Adjust the scene to VMC and see if the image horizon is conformal with the visual horizon and the combiner horizon.

(B) Using a VMC night or dusk scene, select a thunderstorm at a distance of at least (37 km) 20 nm and see if the imager detects the clouds.

(v) Approaches:

(A) Normal approach in night VMC conditions.

(B) ILS approach.

(a) Select the preset that allows the pilot to see the EFVS image at approximately 500 ft. This shall preset the EFVS visibility to approximately 2 300 m, and the visual RVR to 750 m.

(b) Fly or reposition the aircraft to 500 ft above ground level (AGL) on the ILS. Freeze position. The pilot flying (PF) shall be able to see the image of the runway approach lights. The pilot not flying (PNF) shall not be able to see any lights. (Some very slight bleed through of strobes is acceptable, but no steady lights).

(c) Continue the approach and freeze position at 200 ft AGL. The PF shall be able to see approximately 1 nm down the runway, and the PNF shall be able to visually acquire the approach lights and runway end identifier lights (REILs).

(d) Continue the approach and landing. Observe the blooming effect of the airport lights.

(C) Non-precision approach.

(D) Missed approach.

(E) Note: Emphasis shall be placed on the FSTD’s capability to demonstrate that the EFVS is able to display the required visual cues for the pilot to identify the required visual references to descend below the published decision altitude (DA) when conducting instrument approaches with vertical guidance. The EFVS shall continue to provide glide path and alignment information between DH and touchdown. During landing roll-out, visual alignment information shall be available to the pilot.

(vi) Visual segment and landing:

(A) Normal:

(a) From a non-precision approach.

(b) From a precision approach.

(vii) Abnormal procedures:

(A) EFVS malfunctions on the ground.

(B) EFVS malfunctions in the air.

(e) Due to the uniqueness of this system and the normal FSTD environmental visual selections, the IOS shall have pre-set weather conditions for EFVS operations. Recommended settings are such that EFVS ‘visual’ reference can be attained at approximately 500 ft (150 m) AGL, at CAT I and EFVS authorised minima, and below minima to force a go-around.

CS FSTD.QB.140 Night Vision Imaging System (NVIS) requirements for FSTDs

(a) Applicability

(1) This CS applies to all FSTDs with a night vision imaging system (NVIS), such as night vision goggles (NVG), at Specific or Representative fidelity levels. While the requirements in this CS concern many features, they are given here as a single entity.

(2) For the purposes of this CS, ‘NVIS’ will be used as a general term for Night Vision Imaging System defined as a Direct View (Image viewed directly in-line with the image intensification process), head-mounted, binocular, light intensification appliance that enhances the ability to maintain visual surface reference at night.

(3) Objective tests for new, updated or upgraded FSTDs incorporating an NVIS shall contain an SOJ. The SOJ shall be an attestation that the NVIS hardware and software, including associated displays and annunciation, function in the same way or in an equivalent way to the system(s) installed in the aircraft. A block diagram describing the input and output signal flow and comparing it to the aircraft configuration shall support this SOJ.

(b) FSTD NVIS standards

(1) Whether the NVIS is an actual aircraft system or is software-simulated, the system shall be shown to perform its intended function for each operation and phase of flight.

(2) The minimum FSTD requirements for NVIS in an FSTD to Specific or Representative fidelity level are:

(i) the NVIS FSTD hardware and software, including associated flight deck displays and annunciation, shall function the same or in an equivalent way to the NVIS installed in the aircraft;

(ii) an active display (repeater) of the pilot's combiner shall be located on the IOS, or at another location approved by the competent authority. It shall include a duplicate display of the NVIS, as seen through the pilot's HUD combiner glass or the flight deck flight displays; and

(iii) The FSTD environment must be suitable for NVIS training:

(A) Windshield panes are required for any FSTD used for NVIS training tasks. The effects of the windshield on NVIS visual and non-NVIS visual shall be similar as possible to the aircraft.

(B) Displays or lighting outside of the flight deck area, if installed, do not interfere or distract from NVIS training.

(C) Rotorcraft operational steerable (visible light, non-IR) searchlight or aeroplane landing/taxi lights, as appropriate for the aircraft configuration, used for identification of wires, poles and other obstructions during landing, take-off and enroute. Use of the searchlight shall realistically aid in detection of poles and wires and obstacles.

(D) Suitable seat adjustment for proper NVIS training.

(E) Proper flight deck lighting, suitable for NVIS training.

(F) No distracting light leaks, glare or unrealistic halo effects.

(G) External lighting does not interfere or distract from NVIS training.

(c) Objective testing

Refer to Subpart D objective test section 4.d.

(d) Subjective testing

(1) Handling qualities, performance, and FSTD systems operation, while using the NVIS, shall be subjectively assessed.

(2) The ground and flight tests and other checks required for qualification of the NVIS are listed below. They include manoeuvres and procedures to assure that the NVIS functions and performs appropriately for use in pilot training and checking in the manoeuvres and procedures and/or special areas of emphasis. The testing shall be conducted using night conditions. The visual scene shall simulate the actual night environment as viewed both aided and unaided at moon illumination levels between 0% and 100%. If moon elevation angles other than 90 degrees are simulated, then shadows computed as a function of moon angle shall be displayed. Required testing:

(i) IOS:

(A) Check to ensure that the IOS has preset selections that match the training programme.

(ii) Pre-flight:

(A) Inspect and adjust NVIS appliances in accordance with the operator's approved (OEM recommended) procedures.

(B) Evaluate flight deck environment for suitability of head-mounted NVIS. Determine ability to view flight deck instrumentation, switches, and controls below NVIS field of view.

(C) Carry out normal pre-flight procedures and checks, including warnings and annunciations.

(iii) Taxi / Take-off:

(A) Evaluate the use of NVIS for focus, depth perception, brightness, contrast, and field of view while performing the following tasks:

(B) Taxiing, on wheels (rotorcraft and aeroplane) and/or while hovering (rotorcraft).

(C) Normal take-off from a hover (rotorcraft) or Normal rolling take-off (aeroplane).

(D) Take-off with abnormal occurrence: Engine failure, CAT A / B.

(iv) In-flight operations:

(A) Check for adequate ground reference while straight and level.

(B) Check for adequate ground reference while manoeuvring: turns, climbs and descents.

(C) Night scenes with a moon shall be evaluated for suitability with NVIS.

(D) Navigate to a designated area via ground reference.

(E) Check navigation by instruments.

(F) Check system parameters (instruments, panel illumination, ability to read checklists, etc.).

(v) Approaches:

(A) Visual approach to a confined area or unimproved / unlit runway without reference to ground lighting.

(B) Engine out approach for multi-engine aircraft.

(C) Respond to a change from VMC to instrument meteorological conditions (IMC).

(vi) Abnormal procedures:

(A) During hover, take-off, cruise, approach and landing.

(B) Malfunctions may be selected from the Operator's Approved Flight Manual Abnormal Procedures section.

(vii) Note: Emphasis shall be placed on the FSTD's capability to demonstrate compatibility for NVIS training and the ability to display adequate visual scenes such that the pilot can identify the required visual references for night VFR flight.

CS FSTD.QB.150 Qualification of an FSTD with an XR System

(a) Applicability

(1) FSTDs may use a Head Mounted Display (HMD) as part of the FSTD for the use of Extended Reality (XR). XR based environments include the use of a Virtual Reality (VR) display, an Augmented Reality (AR) display, or otherwise Mixed Reality (MR) displays. Where an XR system is used, Special Conditions may be used to define adequate or appropriate standards for the FSTD as part of the Qualification Basis.

(2) Extended Reality (XR) is an encompassing term to refer to Virtual Reality (VR), Mixed Reality(MR) and Augmented Reality (AR).

(i) Virtual Reality (VR) – The environment is completely represented virtually on a head mounted display (HMD).

(ii) Augmented Reality (AR) – The real world element is enhanced with a virtual overlay component using a see-through head mounted display (HMD).

(iii) Mixed Reality (MR) – The real environment (including camera perceived) elements and computer-generated elements are merged. Physical and virtual content are presented to the observer on a head mounted display. All elements may co-exist in MR and interact in real-time. (For example the image from a head mounted camera system is presented within a virtual environment, VE).

(b) FSTD standards: The Special Conditions of the qualification basis shall take into account the general requirements for XR systems included in Subpart B of this CS:

(1) Flight Deck Layout And Structure (CS FSTD.QB.101)

(2) Visual Cueing (CS FSTD.QB.111); and

(3) Miscellaneous (CS FSTD.QB.115).

(c) Visual Cueing: Head Mounted Displays may use one of the XR technologies (AR, MR, VR), the requirements of which will differ depending on the technology used. The general requirements for XR systems using an HMD are described in Subpart B. Where a technology is not described, Special Conditions shall be used.

(d) Motion Cueing considerations: For cyber sickness prevention and avoidance of negative training, a 6 DoF motion platform may be used in combination with the HMD. A motion platform with a reduced envelope is considered to be acceptable.

(e) Objective testing: The objective tests associated with the validation and verification of the performance for XR display based FSTDs (e.g. including FSTDs with a VR display system) shall be defined in Special Conditions as part of the Qualification Basis.

(f) System Setup: A statement of justification is required to explain the system setup for the XR system to describe the overall concept with regards to flight deck and environment representation, interaction with the flight deck and the technology used, including the HMD.

CS FSTD.QB.155 Multi-configuration devices and their MQTG requirements

(a) Multi-configuration devices are FSTDs that host multiple configurations of aircraft, aircraft systems, avionics, engine types/ratings, and may or may not utilise different flight deck and platform combinations. For devices with major interchangeable assemblies, platforms contain the motion and visual aspects of the device into which various flight decks are inserted.

(b) Multi-configuration devices shall have accompanying SOJs, objective tests, and information for each applicable configuration in the required MQTG(s). Every FSTD requirement (general requirements, objective tests, functions and subjective tests) shall be addressed for each configuration. The MQTG(s) shall be appropriately arranged so that it is clear how each configuration impacts the device, applicable tests, and applicable requirements. The impacts shall be specifically addressed through the use of rationales and SOJs addressing which requirements and tests are applicable and common between configurations and which are independent of the configuration and why.

(c) Convertible FSTD may have objective tests and functions and subjective tests that are applicable only for one FSTD configuration.

GM1 FSTD.QB.155 Multi-configuration devices and their MQTG requirements

The following general principles should be followed and are applicable to all FCSs.

(a) Simulation software

(1) Every FSTD configuration is affected by the software architecture. Convertible FSTD platforms may use different software modules or software loads for each FSTD configuration. The configuration control system should cover convertible FSTD platforms and their unique features.

(2) If the software changes between FSTD configurations are known to affect objective tests (e.g. affect handling characteristics or transport delay, etc.), then separate objective test cases should be prepared for each FSTD configuration. The MQTG (see CS FSTD.QB.030) should describe how the software loads and modules are structured for each FSTD configuration. This will indicate if separate objective tests are needed or not.

(b) Visual system

Visual objective tests particular to each configuration such as visual ground segment, system geometry, and qualification airfield for each configuration if applicable (e.g. devices with interchangeable flight decks) should be performed with each configuration. An SOJ should be given to indicate which tests are independent of configuration.

(c) Transport delay or latency objective tests

Consideration should be given to transport delay or latency tests, since different configurations may use different software modules, software loads, hardware and avionics that may have an effect on the results. If this is not considered applicable by the applicant (e.g. because the software loads differ only so slightly that it does not affect transport delay), an SOJ should be provided.

(d) Convertible avionics

(1) Convertible avionics are different avionics suites, optional flight management and guidance computers (FMGC), selectable avionics options and different flight augmentation computer standards or versions.

(2) Convertible avionics should be segmented into those systems or components that can significantly affect the objective test results and those that cannot. This analysis should be done by the organisation requesting qualification of an FSTD supported by the aircraft manufacturer, avionics manufacturer, data provider or FSTD manufacturer (or a combination of them) on a case-by-case basis as appropriate. (See CS FSTD.ENG.030.)

(3) When a convertible avionics configuration can affect the objective test results, then additional objective test cases should be included for all appropriate configurations.

(e) Alternate systems or equipment

(1) Typical examples of alternate systems or equipment are different brake systems (e.g. steel and carbon brakes) and system configurations for aircraft performance purposes (e.g. symmetric aileron deflection for take-off).

(2) When alternate systems or equipment affect the objective test results, additional objective test cases should be included for all appropriate configurations.

(f) Alternate engine type(s) and rating(s)

(1) Objective tests should validate engine type and rating characteristics for each device configuration. CS FSTD.ENG.030 requirements for alternate engine types and ratings can be used across device configurations with appropriate additional objective tests, SOJs, and rationales.

(g) Different aircraft classes, groups, types and variants

(1) If multiple aircraft types are simulated, each should have a complete and separate MQTG, except for those tests that are independent of the configuration.

(2) When a single aircraft type with multiple variants are simulated, the configurations can affect the objective test results, additional objective test cases should be included for all appropriate configurations to validate the variants. The additional objective tests may be included as an appendix to the MQTG.

(3) If an FSTD simulates aircraft in multiple classes with one or more features of the Aircraft simulation FSTD features group at Generic fidelity level, each configuration should have a complete and separate MQTG, except for those tests that are independent of the configuration.

(h) Devices with major interchangeable assemblies

(1) Devices using major interchangeable assemblies (flight decks and platforms), where noticeable hardware entities or modules are changed in order to change configuration can often affect objective tests.

(2) Devices with major interchangeable assemblies can use various architectures and methods. Not all possible set-ups can be considered in this guidance material due to their number.

(3) Typical examples of devices with major interchangeable assemblies are the so-called roll-on/roll-off solutions where different flight decks can be inserted into different platforms. In addition, the roll-on/roll-off configurations could have further configurations for alternate engines, avionics, etc. See other subparagraphs regarding those configurations.

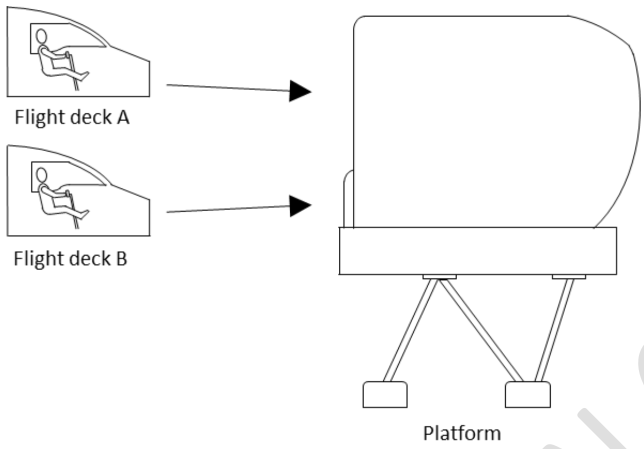

Figure 1. Example of a device with two interchangeable flight decks

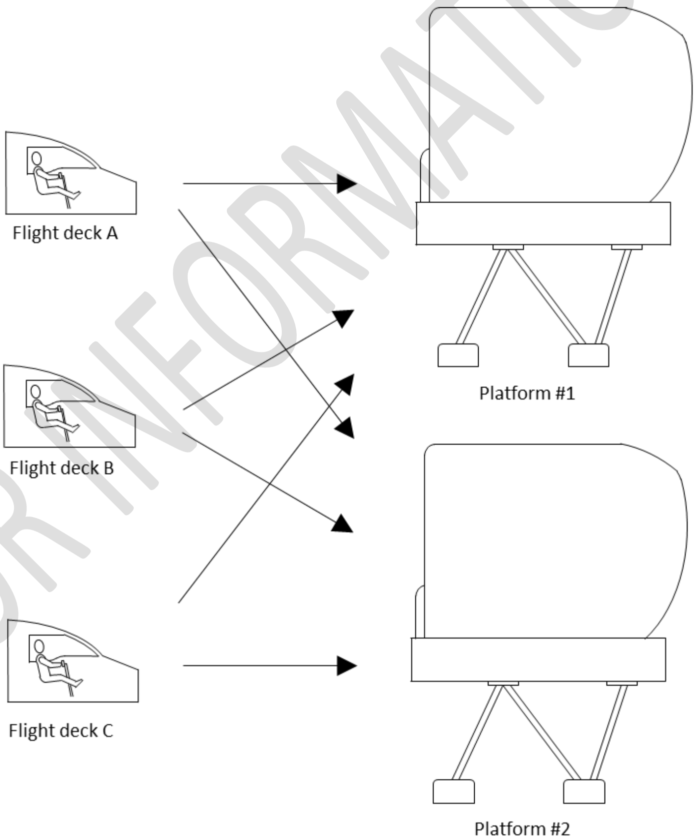

Figure 2. Example of two platforms with three interchangeable flight decks

(4) If each flight deck will be inserted into only one dedicated platform (see Figure 1) then:

(i) The MQTG(s) should address all requirements for each combination of flight deck and platform as appropriate. These may be in the form of SOJs, rationales, and objective tests.

(ii) There should be a complete and separate MQTG for each flight deck; and

(iii) The MQTG should identify the flight deck and platform. The individual objective tests should also identify these.

(5) If each flight deck will be inserted into multiple platforms (see Figure 2) then:

(i) The MQTG(s) should address all requirements for each combination of flight deck and platform as appropriate. These may be in the form of SOJs, rationales, and objective tests;

(ii) Each flight deck should be appointed a platform that would be the primary combination for objective tests. This combination of flight deck and platform should have a complete MQTG;

(iii) The MQTG should identify the flight deck and platform. The individual objective tests should also identify these; and

(iv) Since the flight deck will be inserted into multiple platforms, the MQTG should be amended for each combination of those. The host computer and the software modules may be associated with the platform or the flight deck. This determines to which extent the software is common between flight deck and platform combinations. Hence, it will define which objective tests that may be affected by swaps. For example, if the flight deck will be inserted into two different platforms, then there should be one complete MQTG (i.e. primary combination) and an appendix for the tests related to the alternate platform.

CS FSTD.QB.160 FSTD general requirements for Simulated Air Traffic Control Environment (SATCE)

SATCE is not a mandatory requirement. If the FSTD is requested to be qualified for an SATCE system, the following requirements shall be fulfilled at fidelity level G, R or S.

If SATCE is installed and is to be used, the functions and subjective testing of the FSTD shall be performed to ensure that simulated ATC environment supports the specific training tasks envisaged (for example, as needed for MPL/ab-initio training) in an efficient and effective manner. Emphasis shall be on the approval of those functions that support key training objectives, rather than those that attempt to provide a complete high-fidelity synthetic representation of real-world operations. Since the requirements for simulated ATC environments are intentionally non-prescriptive, the assessment is subjective.

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT
Simulated air traffic control environment (SATCE) is an automated flight training technology, in which air traffic control (ATC) services and other traffic entities are simulated as part of the synthetic environment provided by the FSTD. Instructor role-play of ATC services or other functions, such as ground or cabin crew, is considered outside the scope of a SATCE system, since this approach is not a feature of the FSTD. Note: See CS FSTD.FST.040 for functions and subjective test standards for SATCE.

The general requirements for the simulated air traffic control environment are presented in the table below.

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)						
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.1	SIMULATED AIR TRAFFIC CONTROL					
16.1.1	ATC services shall be automatically provided for at least two operating sites featuring multiple take-off and landing areas, taxi routes and parking locations, with controlled airspace, characteristic of the location supporting standard and regional ATC procedures and associated radio communications during ownship normal, non-normal and emergency conditions.			√		√
16.1.2	Automated weather reporting shall be supported. Data Link communications shall be supported where applicable.			√		√

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)						
	GENERAL REQUIREMENTS	**FEATURE FIDELITY LEVEL**			**VERIFICATION & VALIDATION**	
		G	**R**	**S**	**QTG**	**F&S**
16.1.3	Multiple distinct voices shall be used for both ATC and other traffic radio transmissions.			√		√
16.1.4	Other traffic shall undertake airborne or ground manoeuvres correlated with ATC radio communications, and exhibit characteristic performance, follow appropriate routes and be visible in the scene and on flight deck and instructor displays, including ADS-B traffic information.			√		√
16.1.5	The instructor shall be able to configure traffic flow, have access to all radio communications, as well as the capability to mute and restore background radio communications.			√		√
16.1.6	ATC services shall be automatically provided for at least one operating site featuring at least one take-off and landing area, taxi route and parking location, with controlled airspace, supporting standard ATC procedures and associated radio communications during ownship normal operations.	√				√
16.1.7	Automated weather reporting shall be supported.	√				√
16.1.8	Distinct voices shall be used for both ATC and other traffic radio transmissions.	√				√
16.1.9	Other traffic shall undertake airborne manoeuvres correlated with ATC radio communications, and be visible in the scene and on flight deck and instructor displays, including ADS-B traffic information.	√				√
16.1.10	The instructor shall be able to configure traffic flow, have access to all radio communications, as well as the capability to mute/restore background radio communications.	√				√
16.2	AUTOMATED WEATHER REPORTING Automated weather reporting describes the simulation of fully automatic pre-programmed ATC services delivering reported weather information via radio and data communications. Automated Terminal Information Service (ATIS) is the most common automated weather reporting system. Other reported weather broadcast systems need only be simulated where required to support the intended use.					
16.2.1	More than one automated reported weather message adhering to standard ICAO specifications shall be available to the flight crew.			√		√

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)						
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.2.2	Messages shall include, at a minimum, operating site, reference take-off and landing area, temperature, wind, altimeter setting, clouds, visibility, take-off and landing area conditions, as well as predefined other conditions where required to support the intended use.			✓		✓
16.2.3	The instructor shall have the ability to override message content, and may associate messages with one or more operating sites. Any weather-related ATC communication shall reflect these messages.			✓		✓
16.2.4	A single automated reported weather message adhering to standard ICAO specifications shall be available to the flight crew.	✓				✓
16.2.5	The message shall include, at a minimum, operating site, reference take-off and landing area, temperature, wind, altimeter setting, clouds, visibility, take-off and landing area conditions, as well as predefined other conditions where required to support the intended use.	✓				✓
16.2.6	The instructor shall have the ability to override message content. Any weather-related ATC communication shall reflect this message.	✓				✓
16.3	OTHER TRAFFIC Other traffic describes the simulation of entities other than the ownship, where this supports the intended use. Other traffic may be generated and controlled by systems other than SATCE, such as simulator applications for Traffic Collision Avoidance System (TCAS) training, and the visual display system.					
16.3.1	Fully automated other aircraft traffic shall be present undertaking manoeuvres under air traffic control.			✓		✓
16.3.2	Other aircraft shall exhibit characteristic performance for the aircraft type.			✓		✓
16.3.3	Other aircraft shall land and depart from take-off and landing areas, follow airborne and taxi/air taxi routes, and park at locations appropriate to their category and weight class.			✓		✓

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)							
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.3.4	Other traffic routing shall match information available to the flight crew, and behaviours shall correlate with ATC radio communications.			√		√
16.3.5	Other aircraft minimum separation shall be typical of ATC procedures during normal conditions.			√		√
16.3.6	Other aircraft traffic transponder states shall be simulated and support modes A, C/S and OFF, with the mode of operation appropriate for the phase of flight and aircraft position.			√		√
16.3.7	Other aircraft traffic call signs shall match their liveries, with aircraft types and liveries that are characteristic of operations at the operating site.			√		√
16.3.8	Other aircraft traffic visual effects that provide important cues to the flight crew shall be simulated.			√		√
16.3.9	Fully automated other aircraft traffic shall be present undertaking manoeuvres under air traffic control.	√				√
16.3.10	Other aircraft shall exhibit characteristic performance for the aircraft type.	√				√
16.3.11	Other traffic routing shall match information available to the flight crew, and behaviours shall correlate with ATC radio communications.	√				√
16.3.12	Other aircraft minimum separation shall be typical of ATC procedures during normal conditions.	√				√
16.3.13	Other aircraft traffic call signs shall match their liveries.	√				√
16.4	BACKGROUND RADIO TRAFFIC Background radio traffic (also known as party line or ‘background chatter’) describes the simulation of radio communications between ATC and other traffic, not intended for the ownship.					

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)						
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.4.1	Where other traffic is present, background radio communications shall be available to the flight crew, correct and complete during normal conditions, and correlate with the ATC services offered and other traffic phases of flight, positions and manoeuvres.	√		√		√
16.4.2	In general, the number of background radio communications shall reflect the amount of other traffic manoeuvring in the simulated environment.	√		√		√
16.4.3	Simulated radio transmissions shall not step over transmissions from the flight crew or other simulated entities during normal conditions. The SATCE system shall detect when the flight crew step over simulated radio transmissions from either other traffic or ATC, and support concurrent radio communications on all radios available to the flight crew, where required to support the intended use.	√		√		√
16.5	ATC SERVICES Air traffic control services describe the simulation of various distinct air traffic management roles, often allocated to different frequencies, accessible by the flight crew via simulated radio and data communications.					
16.5.1	ATC services shall be simulated, managing the ownship and other traffic within controlled ground and airspace.			√		√
16.5.2	ATC service roles and allocated frequencies shall correlate with each other and with the information available to the flight crew.			√		√
16.5.3	Standard ATC procedures and associated radio communications shall be simulated and apply to the ownship and other traffic.			√		√
16.5.4	ATC procedures shall be used as published by ICAO or the Air Navigation Service Provider (ANSP) or the national CAA.			√		√
16.5.5	In addition, regional or location-specific ATC published procedures and associated radio communications shall be simulated and apply to the ownship and other traffic.			√		√

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)						
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.5.6	ATC procedures shall correlate with the information available to the flight crew.			✓		✓
16.5.7	Radio transmissions shall be received by the ownship within realistic and typical reception distances.			✓		✓
16.5.8	ATC service provision to other traffic shall maintain continuity across ATC sector boundaries within controlled airspace.			✓		✓
16.5.9	ATC services shall be simulated, managing the ownship and other traffic within controlled ground and airspace.	✓				✓
16.5.10	ATC service roles and allocated frequencies shall correlate with each other and with the information available to the flight crew.	✓				✓
16.5.11	Standard ATC procedures and associated radio communications shall be simulated and apply to the ownship and other traffic.	✓				✓
16.5.12	ATC procedures shall be used as published by ICAO or the ANSP or the national CAA.	✓				✓
16.5.13	ATC procedures shall correlate with the information available to the flight crew.	✓				✓
16.5.14	ATC service provision to other traffic shall maintain continuity across ATC sector boundaries within controlled airspace.	✓				✓
16.6	LANGUAGE AND PHRASEOLOGY Language and phraseology describes the method of simulated ATC communications and the particular set of fixed expressions used.					
16.6.1	Background radio communications, and those from ATC to the ownship shall be in English as per ICAO Doc 4444 and comply, where possible, with the phraseologies detailed in ICAO Doc 4444 and ICAO Annex 10, including those with PANS status, supported by ICAO Doc 9432.			✓		✓

<table>
<tr><th colspan="7">SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)</th></tr>
<tr><th colspan="2">GENERAL REQUIREMENTS</th><th colspan="3">FEATURE FIDELITY LEVEL</th><th colspan="2">VERIFICATION & VALIDATION</th></tr>
<tr><th></th><th></th><th>G</th><th>R</th><th>S</th><th>QTG</th><th>F&S</th></tr>
<tr><td>16.6.2</td><td>Background radio communications, and those from ATC to the ownship shall include published regional or location-specific phraseology.</td><td></td><td></td><td>√</td><td></td><td>√</td></tr>
<tr><td>16.6.3</td><td>Background radio communications, and those from ATC to the ownship shall be in English as per ICAO Doc 4444 and comply, where possible, with the phraseologies detailed in ICAO Doc 4444 and ICAO Annex 10, including those with PANS status, supported by ICAO Doc 9432.</td><td>√</td><td></td><td></td><td></td><td>√</td></tr>
<tr><td>16.7</td><td colspan="6">VOICE CHARACTERISTICS
Voice characteristics describe the features and qualities of simulated speech used for radio communications. Where this is achieved automatically using synthetic speech generation technologies, the focus shall be on achieving realistic voice audio from ATC services over that from other traffic.</td></tr>
<tr><td>16.7.1</td><td>Radio transmissions to the ownship shall occur using the same ATC voice or voices used to simulate ATC transmissions to other traffic.</td><td></td><td></td><td>√</td><td></td><td>√</td></tr>
<tr><td>16.7.2</td><td>ATC voices shall be dedicated to the ATC function for the duration of a training scenario. Distinct voices shall be assigned to both the ATC function and other traffic that are diverse enough to distinguish between ATC services and other traffic.</td><td></td><td></td><td>√</td><td></td><td>√</td></tr>
<tr><td>16.7.3</td><td>Where more than one frequency or ATC service is simulated, multiple distinct voices shall be assigned to the ATC function, as would be experienced in real-world operations. The number of voices shall allow differentiation between ATC services, to the extent required to support the intended use.</td><td></td><td></td><td>√</td><td></td><td>√</td></tr>
<tr><td>16.7.4</td><td>Where more than one other traffic is simulated, multiple distinct voices shall be assigned to other traffic. The number of voices shall allow differentiation between other traffic, to the extent required to support the intended use.</td><td></td><td></td><td>√</td><td></td><td>√</td></tr>
<tr><td>16.7.5</td><td>Radio transmissions to the ownship shall occur using the same ATC voice or voices used to simulate ATC transmissions to other traffic.</td><td>√</td><td></td><td></td><td></td><td>√</td></tr>
</table>

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)							
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.7.6	ATC voices shall be dedicated to the ATC function for the duration of a training scenario. Distinct voices shall be assigned to both the ATC function and other traffic that are diverse enough to distinguish between ATC services and other traffic.	✓				✓
16.8	OPERATING SITE AND AIRSPACE MODELLING Operating site and airspace modelling describes the scope of data and functionality required for the simulation of ATC services and other traffic on the ground and in controlled airspace. Modelling requires data that may include ATC-related airspace data, ATC procedures and operating site data. Not all areas of an operating site or airspace need to be modelled or have the same fidelity level, provided that ATC services and other traffic are simulated to the extent and exactness required to support the intended use.					
16.8.1	A simulated ATC environment shall be available at more than one operating site, supporting the simulation of ATC services for controlled airspace characteristic of the location.			✓		✓
16.8.2	ATC services shall be modelled on real-world data, where available, from the location or the ANSP or the national CAA.			✓		✓
16.8.3	Multiple ground movement areas, including take-off and landing areas, taxi routes and parking locations shall be simulated, where this reflects real-world operations at the operating site.			✓		✓
16.8.4	Ownship and other traffic movements shall be simulated to reflect real-world operations at the operating site and where required to support the intended use.			✓		✓
16.8.5	Ownship and other traffic movements on more than one physical take-off and landing surface shall be simulated, where the real-world operating site has multiple take-off and landing areas and where required to support the intended use.			✓		✓
16.8.6	Location-specific operational limitations may be reflected in traffic movements.			✓		✓

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)						
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.8.7	Take-off and landing area operation modes shall reflect real-world operations at the operating site, and where required to support the intended use.			√		√
16.8.8	The lighting state for all open take-off and landing areas, including lighting configuration and intensity, shall correlate with routine ATC traffic movement procedures for site operations, time of day, and reported weather.			√		√
16.8.9	Ground lighting states shall correlate with ATC clearances to the ownship and other traffic.			√		√
16.8.10	A simulated ATC environment shall be available at a minimum of one operating site, supporting the simulation of ATC services for controlled airspace.	√				√
16.8.11	Ground movement areas shall include, at a minimum, one take-off and landing area, taxi route and parking location that are connected.	√				√
16.8.12	Ownship and other traffic movements shall be simulated.	√				√
16.8.13	The lighting state for all open take-off and landing areas, including lighting configuration and intensity, shall correlate with routine ATC traffic movement procedures for site operations, time of day, and reported weather.	√				√
16.8.14	Ground lighting states shall correlate with ATC clearances to the ownship and other traffic.	√				√
16.9	WEATHER Weather describes the simulation of ATC procedures and other traffic routing and behaviours influenced by meteorological conditions.					
16.9.1	ATC services shall implement appropriate procedures for the reported weather for the location, during the simulation of normal conditions. Similarly, traffic departure and arrival routing, active take-off and landing areas and the direction of take-off and landing shall be consistent and congruent with the reported weather at the operating site.	√		√		√

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)							
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.10	VOICE COMMUNICATIONS Voice communications describes air traffic control service provision and radio communications between ATC and the ownship.					
16.10.1	The SATCE system shall support both ATC- and flight crew-initiated radio communications. ATC radio communications shall be correlated with the time in use in the flight deck. ATC radio communications to the ownship shall use the same voices used to simulate radio communications from ATC to other traffic, and correlate with the ATC services offered and the ownship operational context.			✓		✓
16.10.2	ATC services shall support radio communications to and from the ownship using standard phraseology (where defined) during ownship non-normal and emergency conditions.			✓		✓
16.10.3	ATC service provision to the ownship shall maintain continuity across ATC sector boundaries within controlled airspace ensuring there is no loss or interruption of services during normal conditions.			✓		✓
16.10.4	Standby responses and requests for repeated information from either ATC or the flight crew shall be supported. ATC shall be capable of responding to or correcting content errors and omissions in flight crew radio transmissions and responding to a radio transmission on an incorrect or inappropriate frequency. Similarly, ATC shall be capable of responding to the ownship not following an ATC clearance or instruction. ATC shall clear the ownship to follow routing according to the ownship flight plan that follows published routes, where available.			✓		✓
16.10.5	During normal conditions, ATC shall clear the ownship to land and depart from take-off and landing areas designated for the ownship aircraft category and weight class.			✓		✓
16.10.6	ATC shall clear the ownship to follow taxi routes and park at locations appropriate to the ownship aircraft category and weight class.			✓		✓

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)						
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.10.7	The SATCE system shall support both ATC- and flight crew-initiated radio communications. ATC radio communications shall be correlated with the time in use in the flight deck. ATC radio communications to the ownship shall use the same voices used to simulate radio communications from ATC to other traffic, and correlate with the ATC services offered and the ownship operational context.	√				√
16.10.8	ATC service provision to the ownship shall maintain continuity across ATC sector boundaries within controlled airspace ensuring there is no loss or interruption of services during normal conditions.	√				√
16.10.9	Standby responses and requests for repeated information from either ATC or the flight crew shall be supported. ATC shall be capable of responding to or correcting content errors and omissions in flight crew radio transmissions and responding to a radio transmission on an incorrect or inappropriate frequency. Similarly, ATC shall be capable of responding to the ownship not following an ATC clearance or instruction. ATC shall clear the ownship to follow routing according to the ownship flight plan that follows published routes, where available.	√				√
16.10.10	During normal conditions, ATC shall clear the ownship to land and depart from take-off and landing areas designated for the ownship aircraft category and weight class.	√				√
16.11	DATALINK COMMUNICATIONS Data link communications describes the simulation of certain non-voice messages between ATC services and the ownship. Data link communications features and messages need only be simulated where applicable or relevant to the aircraft type and operation. Due to the specific nature of data link communications, it may not be practical to simulate generic communications. Datalink communications that are unrelated to ATC (such as company communications, email services) are not required.					
16.11.1	Data link messages shall follow a correct and coherent sequence of transmissions, with delays in message timing that are characteristic of real-world operations.			√		√
16.11.2	Data link messages, contracts and connections shall result in correct flight deck visual or audio indications.			√		√

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)						
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.11.3	ATS clearance messages shall be consistent with published routes, waypoints, flight information regions (FIRs), and real-world ATC centres.			√		√
16.11.4	Data link weather messages shall correlate with reported weather conditions.			√		√
16.11.5	The simulation of data link initialisation capability (DLIC) shall allow the flight crew to establish a connection with a controller pilot data link communications (CPDLC) service provider that corresponds to a real-world facility.			√		√
16.11.6	The ownship shall be transferred between active data authorities at the appropriate time or distance from a control boundary.			√		√
16.11.7	CPDLC simulation shall support the flight crew in sending and receiving messages that are consistent with regional protocols and in the use of the message set available for the corresponding active data authority.			√		√
16.11.8	Automatic dependent surveillance-contract (ADS-C) messages shall be available through simulated real-world data authorities that support ADS-C messaging.			√		√
16.11.9	Flight information services broadcast (FIS-B) messages shall be supported and correlated with other reporting systems available to the flight crew.			√		√
16.11.10	Data link service failures and recovery, including CPDLC service failures, shall be supported.			√		√
16.11.11	Message timing delays shall be characteristic of real-world operations.			√		√
16.12	SYSTEM CORRELATION System correlation describes the features necessary for a SATCE system to be consistent and congruent with various FSTD systems, so that all information concerning the simulated ATC environment available to the flight crew and instructor, including navigation data, visual and audio cues, are in harmony.					

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)						
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.12.1	Where weather conditions or range permit, other aircraft traffic within visual range of the ownship shall be apparent to the flight crew. Other aircraft positions and routing shall be aligned with the visual display system operating site model. Clutter generated and controlled by the visual display system shall avoid causing a conflict with the ownship or with other traffic. Airspace volumes and sectorisation and other aircraft traffic positions and routing shall be aligned with navigation data available to the flight crew. Other traffic within range shall be shown on flight deck displays.			✓		✓
16.12.2	Where the aircraft simulated is equipped with ADS-B IN capability, and where other traffic is equipped with ADS-B OUT capability, other traffic ADS-B information shall be available to the flight crew.			✓		✓
16.12.3	Where the aircraft simulated is equipped with TCAS capability, appropriate TCAS traffic advisories and resolutions shall be triggered by other traffic.			✓		✓
16.12.4	Standard procedures and associated pilot and ATC radio communications to an ownship TCAS event shall be supported in accordance with ICAO Doc 4444.			✓		✓
16.12.5	Where weather conditions or range permit, other aircraft traffic within visual range of the ownship shall be apparent to the flight crew. Other aircraft positions and routing shall be aligned with the visual display system operating site model. Clutter generated and controlled by the visual display system shall avoid causing a conflict with the ownship or with other traffic. Airspace volumes and sectorisation and other aircraft traffic positions and routing shall be aligned with navigation data available to the flight crew. Other traffic within range shall be shown on flight deck displays.	✓				✓
16.12.6	Where the aircraft simulated is equipped with ADS-B IN capability, and where other traffic is equipped with ADS-B OUT capability, other traffic ADS-B information shall be available to the flight crew.	✓				✓
16.12.7	Where the aircraft simulated is equipped with TCAS capability, appropriate TCAS traffic advisories and resolutions shall be triggered by other traffic.	✓				✓

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)						
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.13	INSTRUCTOR INTERFACES AND CONTROLS Instructor interfaces and controls describe the functions and capabilities necessary for the instructor to obtain information and manage the SATCE system, usually from the IOS. SATCE shall reduce instructor workload for certain tasks, such as the need to provide ATC services to the ownship.					
16.13.1	Visibility of the wider traffic context and other traffic information shall be available to the instructor during training. The instructor shall have access to flight crew and ATC radio communications, and where required to support the intended use, access to data link communications.			✓		✓
16.13.2	The SATCE system shall support the most commonly used simulation control and scenario set-up functions with minimal training disruption and instructor management, including total / flight freeze, resets and repositions. The instructor shall be able to disable all SATCE functionalities during training and return to ATC simulation by manual role play. The instructor shall be able to mute background radio communications and then restore the audio with minimal impact on training.			✓		✓
16.13.3	The instructor shall have the ability to select whether other aircraft traffic is present prior to or during training. The amount of other traffic manoeuvring in the simulated environment shall be configurable prior to training.			✓		✓
16.13.4	Visibility of the wider traffic context and other traffic information shall be available to the instructor during training. The instructor shall have access to flight crew and ATC radio communications.	✓				✓
16.13.5	The SATCE system shall support the most commonly used simulation control and scenario set-up functions with minimal training disruption and instructor management, including total / flight freeze, resets and repositions. The instructor shall be able to disable all SATCE functionalities during training and return to ATC simulation by manual role play. The instructor shall be able to mute background radio communications and then restore the audio with minimal impact on training.	✓				✓

SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)						
GENERAL REQUIREMENTS		FEATURE FIDELITY LEVEL			VERIFICATION & VALIDATION	
		G	R	S	QTG	F&S
16.13.6	The instructor shall have the ability to select whether other aircraft traffic is present prior to or during training. The amount of other traffic manoeuvring in the simulated environment shall be configurable prior to training.	√				√

SUBPART C — ENGINEERING JUSTIFICATION

CS FSTD.ENG.001 General

(a) Subpart C establishes the types of data and associated documentation required to be used to validate the aircraft and cueing groups of simulation features during an initial evaluation.

(b) The FCS indicates how closely the FSTD simulates the aircraft, cueing, and environment. The word ‘aircraft’ here means any aircraft used as a reference for the FSTD. It can be an aircraft type and variant (fidelity level S), an aircraft type (fidelity level R), or a class or group of aircraft (fidelity level G). For example, if the Performance And Handling features are at a Specific fidelity level, the FSTD shall be within certain tolerances to the real aircraft type and variant and shall hence fly and handle very similarly to the real aircraft type and variant. Data from the real aircraft type and variant therefore is needed to build the simulation and to show that objective tests are within tolerances. At lower levels, the requirements are correspondingly lower.

(c) Two types of data are required for the development and qualification of an FSTD:

(1) Design data shall be used to develop simulation models and flight deck hardware

(2) Validation data shall be used to objectively confirm that the simulation models reflect the static and dynamic performance characteristics of the aircraft, and that the cueing features (where required to be objectively validated) conform to the aircraft. Acceptable sources of validation data are described in this subpart.

(d) An Engineering Report (ER) shall be provided as part of the MQTG for all FSTDs, regardless of fidelity level. The ER shall establish and justify the sources of design data and validation data.

(e) A Validation Data Roadmap shall be provided as part of the MQTG for any FSTDs, regardless of fidelity level, except as noted in CS FSTD.ENG.005. The Validation Data Roadmap shall define the validation data to be used with each objective test. Multiple VDRs may be provided where appropriate, such as when the validation data are from multiple data providers or aircraft variants, or when the different aircraft features are based on different VDRs. The VDR(s) shall be acceptable to the competent authority.

(f) The VDR(s) shall be submitted to the competent authority as early as possible in the planning stages for any FSTD planned for qualification to the standards contained herein.

GM1 CS FSTD.ENG.001 General

While this subpart is primarily concerned with design and validation data to support the aircraft simulation features, the cueing features and transport delay tests should also be taken into consideration. For example, the various data reports may include information related to the position of the pilot eye and the flight deck cut-off angle (visual ground segment test), information related to the computation of the transport delay or latency tests, vibration and sound reference data, etc.

CS FSTD.ENG.010 Design data

(a) Design data comprises the set of aircraft, systems, and other data used to develop and test the simulation models, flight deck hardware, and other simulation features. Design data may be collected from multiple sources.

(b) The Engineering Report shall include a clear description and justification of all design data sources.

GM1 CS FSTD.ENG.010 Types of design data

(a) Design data may be provided from multiple sources, in accordance with the requirements for each feature fidelity level. Table 1 provides a non-exhaustive list of examples of applicable design data sources for each feature fidelity level.

Table 1. Examples of design data sources applicable to each fidelity level

Design data source	G	R	S	Comments
Aircraft manufacturer data	✓	✓	✓	
Avionics and systems manufacturer data	✓	✓	✓	e.g. systems descriptions, wiring diagrams
Supplemental Type Certificate Holder	✓	✓	✓	
Genuine aircraft software/hardware	✓	✓	✓	e.g. stimulated or rehosted avionics and systems
Genuine simulation software package	✓	✓	✓	e.g. aircraft manufacturer simulation software
FAA Alternative Data	✓	✓		Refer to 14 CFR Part 60 Appendix B
Aircraft manuals	✓	✓		
System descriptions	✓	✓		
Public domain data	✓			
Other FSTDs	✓			

(b) In order to demonstrate compliance with the requirements for the Aircraft Systems at Specific or Representative fidelity levels, the aircraft system simulation should be based on and be traceable to the design data source for the simulated aircraft. This traceability is important due to the diversity of aircraft systems and the various simulation methods and data acquisition techniques.

GM2 CS FSTD.ENG.010 Design data justification

The Engineering Report should contain descriptions of any design data used in the development of the FSTD and simulation models.

The quality, fidelity and scope of the design data should be adequate to ensure that the FSTD and the simulation models can be built to support positive transfer of training in the applicable flight envelope and that the FSTD is characteristic of the simulated aircraft`.

Design data is especially important for modelling the aircraft flight characteristics, including flight controls system operation, aircraft systems, and performance and handling related features.

Design data is needed for the flight deck layout and structure, to ensure proper touch and feel. Examples include flight deck dimensions, hardware, materials, button and knob movements ranges, etc.

The simulation of aircraft system operation (e.g. logic, indications, delays, system inter-dependencies, etc.) requires data. The source of this data could be OEM design data or aircraft testing. Systems models developed by reference to aircraft test data instead of OEM design data should use very systematic and comprehensive methods to acquire the necessary data. Due to this complexity, the Engineering Report should demonstrate that the data gathering and model development process was appropriate to the fidelity level.

The competent authority may require further information on the design data whenever necessary.

CS FSTD.ENG.015 Validation data

(a) Validation data comprises the set of aircraft and other data to be compared against FSTD objective test results in the MQTG to demonstrate that the simulation and simulation models are within the set tolerances. The source of validation data for each objective test shall be defined by the Validation Data Roadmap (VDR), as described in CS FSTD.ENG.025. Validation data not derived from aircraft flight test or engineering simulation, shall be substantiated in the Engineering Report (ER).

(b) Regardless of the source and fidelity level, the validation data shall comply with the objective test requirements in Subpart D. The validation data shall have the appropriate configuration, flight path, trim state, control inputs, etc. as specified in the objective test requirements. Comparison between validation data and FSTD is objective and meaningful only if the validation data quality is adequate.

(c) Validation data variables shall be defined in a nomenclature list along with sign convention. This list shall be included at an appropriate location in the MQTG.

(d) Since individual FSTD features can be at different levels, the validation data requirements shall be considered separately for each feature.

(e) Validation data requirements according to feature fidelity level:

(1) Where the fidelity level is S for the aircraft simulation and cueing features, the initial evaluation shall be based on objective evaluation against validation data for the particular aircraft type and variant.

Validation data within the same aircraft type and/or variant may be acceptable given that the differences and effects are understood and explainable (e.g. engines, avionics, body length). The VDR or Engineering Report shall contain a rationale for using the data, including the expected impact on the FSTD's performance and handling characteristics.

The aircraft manufacturer's flight test validation data is preferred. Validation data from other sources may be used, subject to the review and concurrence of the competent authority. Validation data may include FSTD qualification results (Footprint Data) in isolated cases where specifically allowed by this Certification Specifications.

Submittals of data other than flight tests shall include a rationale or an explanation of validity with respect to available flight test information.

For FSTDs simulating aircraft for which the application for aircraft type certification was issued after 17 February 2014, where the fidelity level is S for the aircraft simulation features, the source data shall be the data as defined by the OSD established in accordance with Part-21.

(2) Where the fidelity level is R for the aircraft simulation and cueing features, the initial evaluation shall be based on objective evaluation against validation data for the aircraft type, complemented if necessary, by subjective development.

Data from multiple variants within the same type may be used to establish the set of validation data, provided the differences between variants are properly accounted for.

Validation data other than flight test data shall be substantiated in the Engineering Report to demonstrate that the proposed validation data for the feature in question is characteristic of the aircraft type.

The Engineering Report shall include detailed information on any subjective development and justification of FSTD results. This approach shall be used when agreed with the competent authority.

(3) Where the fidelity level is G for the aircraft simulation and cueing features, the initial evaluation shall be based on objective evaluation against validation data for the aircraft class or group, complemented by subjective development.

Aircraft data is not required for each individual objective test but shall be provided, at a minimum, for each objective test section.

Validation source data other than flight test data shall be substantiated in the Engineering Report to demonstrate that the proposed validation data for the feature in question is characteristic of the aircraft class or group.

The Engineering Report shall include detailed information on any subjective development and justification of FSTD results.

GM1 CS FSTD.ENG.015 Types of validation data

(a) Validation data may be provided from multiple sources, in accordance with the requirements for each feature fidelity level. This section provides a non-exhaustive list of examples and usage. The Engineering Report should include a clear description of all data sources, including the basis for derived parameters. These descriptions may be listed in a Flight Test Report (FTR), if provided, or other document and referenced in the ER.

(b) Examples of validation data:

(1) Flight test data refers to aircraft data collected on the ground and in flight, which is used to objectively confirm that the FSTD reflects the static as well as the dynamic handling and performance characteristics of the simulated aircraft and its relevant

systems. Flight test data should be collected using a calibrated data acquisition system of sufficient resolution and verified as accurate.

(2) Published performance data refers to the data used by pilots for flight planning purposes. Performance data may include cruise speeds, climb rates, stopping distances, stall speeds, hover ceilings, etc. When using performance data to support validation for fidelity levels S and R, the Engineering Report should provide a rationale for any toleranced parameters not included in the performance data. For example, cruise performance data would typically not include stab trim position.

(3) Engineering simulator data is described in CS FSTD.ENG.040.

(4) Alternative flight test data refers to aircraft data collected on the ground and in flight, using cost-effective methodologies to support fidelity levels R and G. Such alternative methodologies, when properly executed, do not require external instrumentation or other equipment which would impact the aircraft's airworthiness.

Examples of alternative methodologies include flight deck video recordings, recordings from an electronic data bus or aircraft data recorder (avionics data card or databus output, Health and Usage Monitoring Systems (HUMS), FDR, etc.), and manually-recorded kneeboard data.

Using alternative flight test methodologies, some parameters may be derived rather than measured directly. For example, angle of attack (AOA) can be sufficiently derived if the flight test programme ensures the collection of acceptable level, unaccelerated, trimmed flight data. Angle of attack may be validated by conducting the three basic 'fly-by' trim tests. The FSTD time history tests should begin in level, unaccelerated, and trimmed flight, and the results should be compared with the flight test pitch angle. Similarly, control surface positions can be derived from in-flight measurements of flight deck control force/position and on-ground measurements of cable stretch and gearing, accounting for any non-linearities.

Flight deck video should be accurately synchronised with other data sources and should provide sufficient resolution to allow magnification of the display to make appropriate measurement and comparisons. The detail provided by the video should provide sufficient clarity and accuracy to measure the necessary parameter(s) to at least 1⁄2 of the tolerance authorised for the specific test being conducted and allow an integration of the parameter(s) in question to obtain a rate of change. Video data may not provide the time resolution for 'fast' aircraft responses such as short period response or control dynamics.

A typical flight test case using alternative methodologies might acquire data using an inertial measurement system and a synchronised video of the calibrated flight deck instruments, recordings of the force/position measurements of flight deck controls, and a clear visual directional reference for a known magnetic bearing (e.g., a runway centerline). Ground track and wind corrected heading could be used for sideslip angle.

(5) Predictive and theoretical data includes the results of approved or commonly accepted simulations or predictive models, as well as recognised theoretical results. Such data should be described and justified in the Engineering Report.

(6) Footprint Data can be used as validation data for a new FSTD, provided the Footprint Data is properly justified in the Engineering Report. This practice is generally limited to the following use cases:

(i) The original FSTD was qualified to a higher fidelity level than the new FSTD, e.g. the original FSTD test met Level S tolerances against validation flight test data and the Footprint Data will be used as validation data for a Level R test; or

(ii) The original FSTD simulates the same aircraft type as the new FSTD and an essential match can be demonstrated between the Footprint Data and the new FSTD. The Footprint Data should be manually flown by a pilot holding valid licence and rating and having current experience on the aircraft and is deemed acceptable by the competent authority.

(7) FAA alternative data is published in 14 CFR Part 60 Appendix B for different categories of fixed-wing aircraft.

(8) Data in the public domain may include academic publications, NASA technical reports, and other sources known to employ sound engineering methodology.

(9) Aircraft Certification Specifications may be used to substantiate FSTD performance and handling qualities trends for some tests, for example positively damped phugoid and Dutch roll modes. Where the CS only identifies *trends*, it is important to also justify *magnitudes* as part of the Engineering Report. For example, a critically-damped FSTD Phugoid would be justified in trend (positively damped) but not in magnitude (damping ratio too high).

(10) Subjective development may be used to supplement other sources of data, to resolve issues with the available aircraft data, or to tailor the FSTD performance and handling qualities to better match the aircraft, within the constraints of CT&M and based on the judgments of qualified personnel. The subjective development process should be documented in the Engineering Report.

Subjective development may be used to fill gaps in existing data packages for fidelity levels R and G, as described in CS FSTD.ENG.015.

(c) Table 1 provides a summary of acceptable validation data sources for each feature fidelity level. This list is not comprehensive; other sources may be proposed and justified in the Engineering Report.

Sources marked (✓) should be used only where agreed by the competent authority, as they may lack the necessary fidelity or level of detail for assessing tolerances. Where a check mark is not listed, the type of validation data may be used as a secondary source to support the Engineering Report justification.

Table 1 - Summary of validation data sources applicable to each fidelity level.

Validation Data source	G	R	S	Comments
Flight Test Data	✓	✓	✓	Conventional flight test program
Published Performance Data	✓	✓	✓	AFM and RFM charts, OEM performance calculators, etc.
Engineering Simulation Data	✓	✓	✓	Refer to CS FSTD.ENG.040
Predictive and Theoretical Data	✓	✓	(✓)	Permissible for S in isolated cases, with proper rationale
FSTD Footprint Data	✓	(✓)	(✓)	Validation data may be supported by subjective development. Permissible for S in isolated cases, with proper rationale.
Alternative Flight Test Data	✓	✓		Limited-scope flight test program
FAA Alternative Data for FTDs	✓	(✓)		Refer to 14 CFR Part 60 Appendix B
Public Domain Data	✓	(✓)		
Aircraft Certification Specifications	✓	(✓)		

(d) Data Standards

It is beyond the scope of the CS-FSTD to define acceptable standards for aircraft validation data. In general, data should:

(1) Include all parameters necessary for objective comparison against the FSTD. Where the aircraft includes unique characteristics or has a configuration which does not align with the assumptions of this CS, the Engineering Report and MQTG should propose alternative parameters and methodologies to meet the intent of the objective tests.

(i) For example, if the aircraft uses an elevator trim tab instead of stabiliser trim, it would not be acceptable to disregard stabiliser trim tolerances. Intead, the validation data should include trim tab data.

(2) Include both inputs and outputs, with sufficient resolution to repeat the manoeuvre in FSTD.

(3) Include stable trim conditions for several seconds prior to initiating each manoeuvre.

(4) Avoid time shifts between parameters.

It should be noted that the scope of Design and validation data required to support the FSTD development and verification process generally scales with the aircraft performance envelope and complexity. For example, an FSTD simulating a fly-by-wire jet operating at high altitude and high Mach would require substantially more data than an FSTD simulating a piston single aeroplane.

Refer to ARINC Specification 450-1, Flight Simulator Design and Performance Data, as amended, for additional guidance.

(e) The validation data requirements are considered separately for each feature. For example, if the feature Performance And Handling On Ground is at Generic fidelity level, then the validation data for this feature needs to meet only the requirements for the Generic level. If the feature Performance And Handling Out Of Ground Effect of the same device is at a Specific level, then the validation data for this feature needs to meet the requirements for the Specific level.

(f) Guidance on validation data requirements according to feature fidelity level:

(1) Where the fidelity level is R for the aircraft simulation and cueing features and validation data are aggregated from multiple variants within the same type, differences between variants should support a coherent FSTD model. Otherwise, data may need to be limited to a single variant. For example, two helicopter variants may share a common type certificate despite having fundamentally different rotor hub designs. In such a case, all runs within a given test, e.g. lateral control responses in different directions and at different airspeeds, shall use validation data from a single variant so that the proper trends are evident.

(2) Where the fidelity level is G for the aircraft simulation and cueing features, flight test validation data may not be available for each test. For example, alternative flight test data could be used to verify roll response rate during cruise. The same control input could be repeated in the FSTD in a landing configuration without requiring a second flight test case, demonstrating reduced aileron effectiveness at the lower airspeed.

CS FSTD.ENG.020 Engineering Report

(a) This CS provides standards for the Engineering Report (ER), which justifies the data and methods used to design and verify an FSTD against the requirements in this CS. The ER is required for all FSTDs, regardless of fidelity level, and shall be part of the MQTG.

(b) Refer to CS FSTD.ENG.015 for a description of acceptable sources of validation data for each feature fidelity level.

(c) The Engineering Report shall contain the following information:

(1) A description of the scope, sources, and methods for the design data and validation data used to develop and verify each feature of the FTSD.

For flight test validation data, the description may be a reference to the Validation Data Roadmap. For other sources of validation data, particularly alternative flight test data for fidelity levels R and G, the Engineering Report shall include a detailed description of the flight test program or a reference to the validation data provider's flight test report. Any such references shall be included as attachments to the MQTG.

Where applicable, this section shall also include a description of any approved subjective development, including affected objective tests, the process used, and the qualifications of pilots providing subjective feedback.

(2) An explanation of how each objective test shall be verified against validation data, if not included as part of the objective test. This explanation shall include a justification and written discussion for objective test results making use of CT&M tolerances at the initial evaluation, or where a toleranced comparison against the validation data is not possible due to the type of data used (such as with Alternative Flight Test Data and other sources).

Every objective test shall be justified, either with a written description in the Engineering Report or by overplotting the validation data and tolerance bands in the MQTG. Where the feature fidelity level is R or S, overplotting is the preferred means of justification.

Written justification may include the following information, as appropriate for each objective test:

(i) Presentation of the validation data. This could include plots, tables, or text descriptions.

(ii) A written explanation describing why the FSTD's objective test result matches the simulated aircraft within the prescribed tolerances or CT&M. For the cases where there is no data from the real aircraft, other data sources may be used, as described in CS FSTD.ENG.015.

(d) As part of the MQTG, the Engineering Report is considered to be a 'living document', evolving with the FSTD and simulated aircraft. As part of the MQTG, the Engineering Report may be later revised as the FSTD or simulated aircraft may evolve. When a modification to the FSTD requires a corresponding change to the validation data, such as to incorporate a performance update following a change to the aircraft, the Engineering Report shall be updated.

GM1 CS FSTD.ENG.020 Correct Trend & Magnitude

(a) Correct Trend & Magnitude (CT&M) is a method of comparing FSTD objective test results against validation data without the use of numerical tolerances. Results should demonstrate positive correlation between the FSTD and validation data for the inputs and outputs, with values and variations characteristic of the validation data. For example, a flap change should cause the FSTD to pitch in the same direction as the simulated aircraft, with characteristic magnitude. Rationale for any significant differences should be provided as part of the Engineering Report.

Validation data should be overplotted with FSTD results to aid in the assessment of CT&M. Overplotting could occur as part of the objective test, or as supplemental plots provided in the Engineering Report. It is recognized that not all validation data can be overplotted; for example, some data may be provided in tabular form, or at a low sample rate. Overplotting is most important for dynamic manoeuvres such as landings, take-offs, and control responses.

(b) The assessment of objective test results involving CT&M should be based on sound engineering judgement, with a focus on simulation behaviour that may be perceptible to the 'flight crew/pilot' and on replication of the manoeuvre as shown in the validation data.

For objective tests with a CT&M requirement, all the parameters should demonstrate correct trend and magnitude. The main parameter(s) under scrutiny during the test are the primary axis input and output parameters. Good engineering judgement may be applied for the off-axis parameters.

Generic and Representative FSTD features should still clearly resemble the characteristics of simulated aircraft. The 'sensitivity' or 'feel' of flying is largely created by the stability of the aircraft. For positive transfer of training, the FSTD should have similar trend *and* magnitude as the simulated aircraft; it is not sufficient to provide the correct trend while ignoring magnitude.

For example, an FSTD should not be too stable nor too unstable. Excessive stability can be experienced, for example, in Phugoid, Dutch Roll, and spiral stability tests as a very quick return to original flight state. Excessive instability can be seen, for example, as exaggerated pitch changes during short period dynamics tests.

If the FSTD with Performance And Handling features at Generic fidelity levels exhibits exceptionally stable flying characteristics, e.g. no overshoots during a Phugoid test, the Engineering Report should justify this behaviour by providing clear and objective information to show that some aircraft in this class/group has similar stability. If the FSTD handling qualities are too stable relative to the class/group of aircraft, the FSTD is at risk of providing negative transfer of training.

(c) Trend is typically defined as the first time derivative of a given parameter, but the first-order dynamic characteristics (frequency and damping) may also need to be evaluated. Examples of trends include:

(1) The shape and direction of a control response;

(2) Correlation and phase relationships between aircraft degrees of freedom following a control input;

(3) Oscillations increasing or decreasing over time;

(4) Changes in performance with weight, density, and other dependencies;

(5) Changes in control force with airspeed, g loading, and other dependencies;

(6) Tendency to converge or diverge.

If two numbers (such as a change in a flight parameter) have the same order of magnitude, they are about the same size. Magnitude is necessarily subjective and may require justification. Differences in magnitude should be reasonable with respect to the aircraft envelope and scale/precision of the flight deck instruments, and should remain within the same portion of the envelope, unless the trend shows divergence.

(d) Objective tests have different purposes and they measure different aspects and phenomena. Certain parameters require a closer match than others to be considered CT&M. For example, 4 degrees in pitch angle may not be within CT&M, while 4 kts in airspeed would more likely still be acceptable for CT&M. it is impossible to give all-inclusive guidance or criteria to cover all the different objective tests and cases. The following information helps in interpreting and judging whether an objective test demonstrates CT&M.

When a feature is at Generic fidelity level, there is a wide variety of permissible validation data sources. For example, when the validation data for an objective test is subjective development, the FSTD's footprint is justified in the Engineering Report. The justification should carefully explain what is happening in the test (e.g. the flight state and all the movements through the time history) and why the footprint can be considered to be characteristic of the simulated aircraft class or group. Justification of the footprint should always be supported by other sources (e.g. quotation from academic literature that confirms the footprint to be characteristic of the simulated aircraft class or group). Justification for a simple aircraft (e.g. single-engine piston aeroplane) is naturally easier than for more complex aircraft (e.g. multi-engine turbo-jet aircraft with swept wings and non-linearities due to Mach effects, or helicopter with cross-couplings, stabilisation system, etc.). The footprint and the justification together should demonstrate the correct trend and magnitude.

Figure A below shows examples of acceptable CT&M for gear change dynamics for an aeroplane FSTD with Performance And Handling features at Representative level. The figure shows only one plot of the objective test. The validation data is flight test data that is performed by trimming the aircraft for a level flight. Data is recorded for 5 seconds before the landing gear is selected down. The test shows the free response of the aircraft, without moving flight controls during the test. The data is recorded at least 15 seconds after the landing gear has fully extended. The landing gear extension creates drag and causes disturbances to the airflow. This results in a pitching down moment. The airspeed changes and the pitch trim causes a pitch up tendency to return back towards the original airspeed.

The figure also shows two examples of FSTD objective test results. Example #1 begins from a pitch attitude that differs a little from the validation data. Such a difference may be caused by initial trimming or differences in initial conditions. The graph shows good timing and the trend is correct. The change in pitch angle is a little less than in the validation data, but the magnitude can still be considered to be adequate for this test and for this parameter. Note that also other parameters of this test should still be assessed.

Example #2 shows that the pitching begins a little later than in the validation data. This could be due to the simulated extension time of the landing gear. The rationale could show more information on that. The initial trend is correct. The magnitude of the change in pitch angle has a difference but can still be considered acceptable for CT&M. The trend of the pitch up movement at the end of the test is less than in the validation data, but is still in the correct direction and can still be considered acceptable for CT&M.

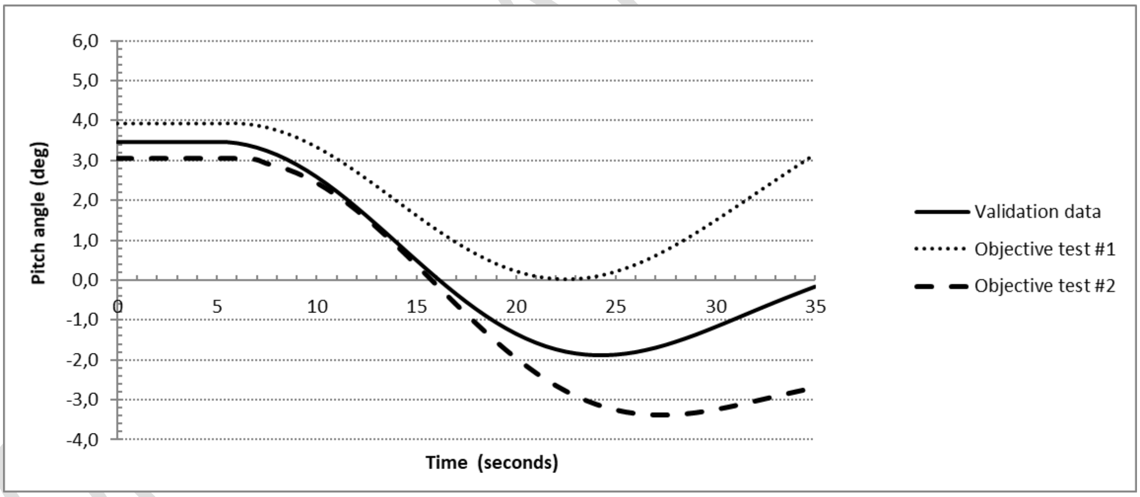

Figure A. Examples of objective test results demonstrating CT&M.

Figure B below shows examples of results that do not demonstrate CT&M. The test and validation data are the same as in Figure A. Example #3 shows pitch movement in the wrong direction, so example #3 does not demonstrate CT&M. Example #4 has the trend in the correct direction, but the trend is clearly less and the magnitude is significantly less than in the validation data, so example #4 does not demonstrate CT&M. Example #5 has the initial trend in the correct direction, but the magnitude of change in pitch angle is clearly more than in the validation data. Also, example #5 does not show a trend of pitching up during the last 10 seconds of the test. These differences indicate a difference that can be noted by the pilots -

the FSTD in example #5 would require more pilot inputs than the real aircraft when the landing gear is extended. Example #5 does not demonstrate CT&M.

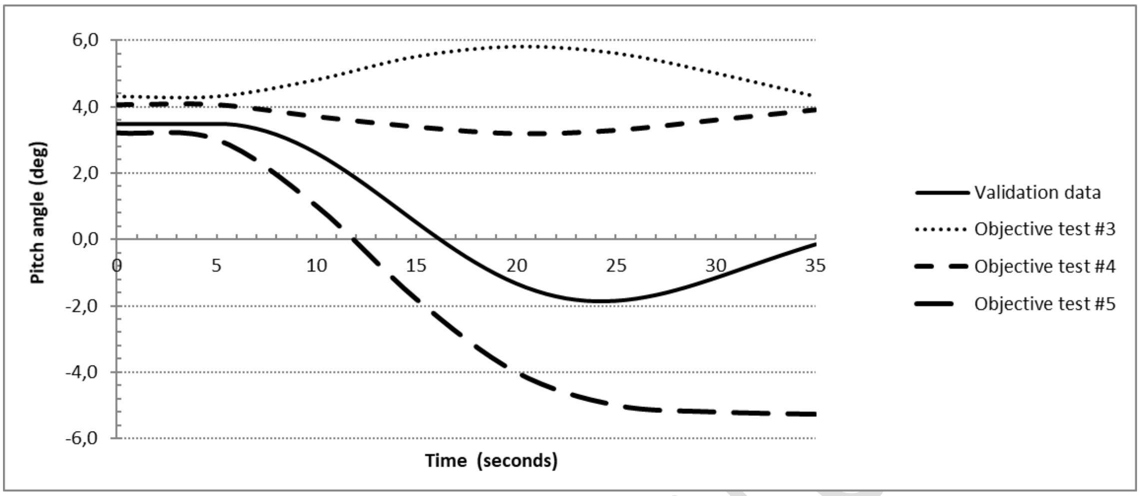

Figure B. Examples of objective test results that do not demonstrate CT&M.

Figure C below shows more examples of results that do not demonstrate CT&M. The test and validation data are the same as in Figure A. Example #6 shows movement in the correct direction with correct pitch rate, but the movement happens after a significant delay. The delay could be caused by test timing, slowness of the simulated gear extension, or by issues with the flight dynamics model. A rationale could be given, but still the timing affects the trend. Example #6 does not demonstrate CT&M. Example #7 has a good trend and magnitude after 5 seconds, i.e. after the landing gear lever is moved. However, the first seconds of the test show that the pitch angle is changing. It means that the FSTD is not trimmed for level flight. The flight state is not correct. The initial test state affects the result (i.e. output) of the test. Because of this, the test results must be deemed as unacceptable. CT&M can't be determined when the initialization (i.e. input) is not appropriate. So, example #7 does not demonstrate CT&M.

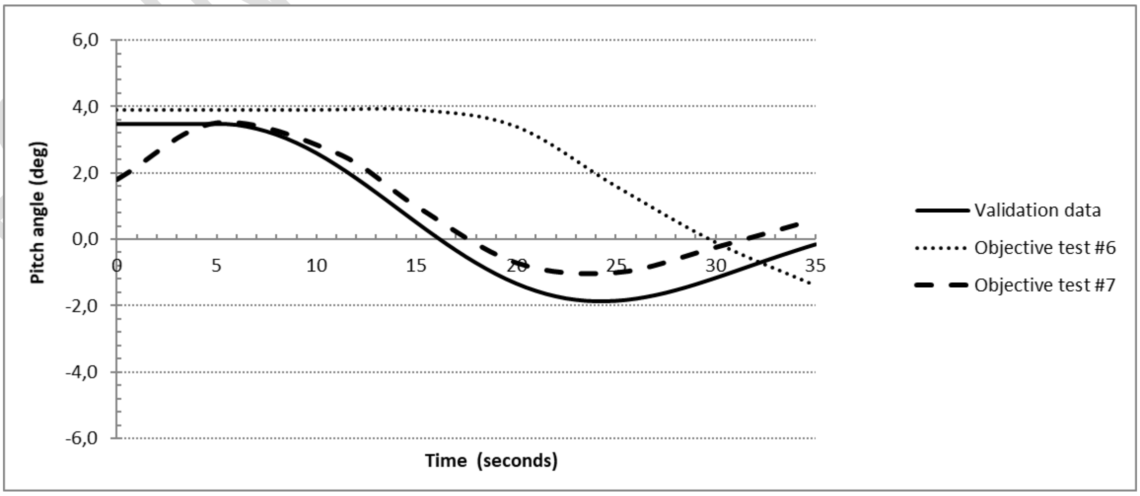

Figure C. Examples of objective test results that do not demonstrate CT&M.

Figure D below shows more examples of results that do not demonstrate CT&M. The test and validation data are the same as in Figure A. Example #8 shows an FSTD result that has an unexplained high-frequency oscillation. The pitch angle of the validation data is changing smoothly so the FSTD's oscillating response to landing gear extension does not show CT&M and is not acceptable. Such a result could be caused by a closed-loop controller that is moving the pitch controller trying to follow the pitch angle. Such a controller should not be used when the test purpose is to measure the free response. Example #9 shows that the FSTD movement happens in the correct direction. But the change happens much quicker, so the trend is questionable. And especially the magnitude of the change is significantly higher than in the validation data. Such an FSTD would 'feel' different from the real aircraft to fly, i.e. it would require clearly more controlling than the real aircraft when the landing gear is extended. Example #9 does not demonstrate CT&M.

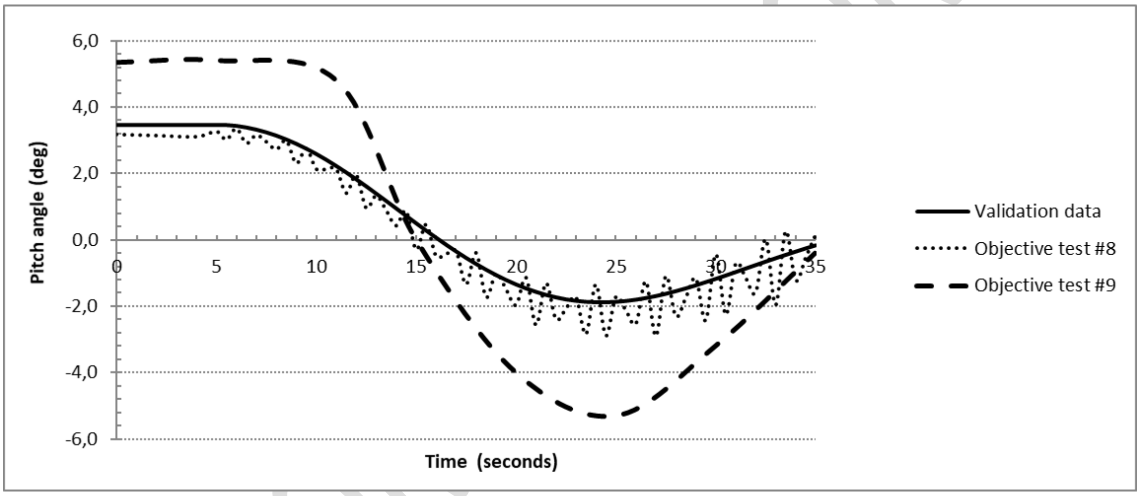

Figure D. Examples of objective test results that do not demonstrate CT&M.

(e) The following are examples of test results that do not demonstrate CT&M:

(1) Dynamics which are overdamped relative to the simulated aircraft, e.g. Phugoid dynamics;

(2) Clearly higher level of stability than in the simulated aircraft, e.g. spiral stability;

(3) Opposite variation of parameters (e.g. pitching up instead of pitching down) following inputs or configuration changes, e.g. speed brake or flap extension;

(4) Insufficient or exaggerated trim change vs. airspeed;

(5) Control forces or travel that clearly differs from the simulated aircraft;

(6) Failure to account for aircraft-specific issues such as weight-on-wheels dependencies;

(7) Lack of roll-yaw coupling in swept-wing Dutch roll;

(8) Lack of cross-coupling in helicopter manoeuvring;

(9) Misapplied aircraft class or group data, e.g. sidestick forces applied to a yoke.

GM2 CS FSTD.ENG.020 Industry standards

(a) In showing compliance, the organisation requesting qualification of an FSTD should account for industry standards and best practices, such as but not limited to:

(1) ARINC Specification 450-1, 'Flight Simulation Training Device Design & Performance Data Requirements', as amended and as appropriate to the FSTD capability signature (FCS).

(2) ARINC Specification 610-1, 'Guidance for Design of Aircraft Equipment and Software For Use In Training Devices', as amended. See also GM1 CS FSTD.FST.001 Guidance for simulator functions.

CS FSTD.ENG.025 Validation Data Roadmap

(a) This CS provides standards for the Validation Data Roadmap (VDR), which defines the source(s) of aircraft data that could be used for validating each objective test result. A VDR document contains guidance material from the aircraft validation data supplier recommending the best possible sources of data to be used as validation data in the QTG.

(b) The VDR is required for all FSTDs, regardless of fidelity level, shall be produced by the validation data provider, and shall be part of the MQTG.

(c) The Validation Data Roadmap shall clearly identify (in matrix format) sources of data for all required tests. It shall also provide guidance regarding the validity of this data for a particular engine type and thrust/torque rating configuration and the revision levels of all avionics affecting aircraft handling qualities and performance. The document shall include rationale or explanation in cases where data or parameters are missing, engineering simulation data is to be used, flight test methods require explanation, etc., together with a brief narrative describing the cause/effect of any deviation from data requirements. Additionally, the document shall make reference to other appropriate sources of validation data (e.g. sound and vibration data documents).

GM1 CS FSTD.ENG.025 Validation Data Roadmap

(a) A VDR should provide clear and explicit information on the validation data sources for each objective test. If the FSTD is based on multiple VDRs (e.g. for different features), the source of validation data for each objective test must be clearly defined. It may be necessary to merge the information from multiple VDRs into one document. The method should be agreed with the competent authority.

(b) A VDR should be submitted to the competent authority as early as possible in the planning stages for any FSTD planned for qualification to the standards contained herein.

(c) Table 1 depicts an example VDR matrix identifying sources of validation data for a typical validation data package to support fidelity level S. Only the first page of the full matrix is shown and some test conditions were deleted for brevity. The first column refers to objective tests in CS FSTD.QTG.105 or to tests in the ARINC 450 document 'Flight Simulation Training Device Design and Performance Data Requirements'.

(d) Relevant regulatory material should be consulted and all applicable tests addressed in the actual VDR document submitted. Validation sources, validation data documents, and comments provided herein are for reference only. The actual data sources and documents will be dependent upon the particular airframe/engine combination under consideration. The following set of guidelines should be used when applying this example to a specific VDR document:

(1) Include CCA mode column if applicable.

(2) Include column for each validation source (e.g. each flight test airframe/engine combination and the simulation configuration).

(3) Include column for each document being referenced as a source of validation data. The term ‘integrated’ in the document title indicates that test conditions contained in these documents conform to the definition of ‘integrated testing’ as described in the glossary.

(e) Data type numbering should align with the hierarchy of preferences outlined in CS FSTD.ENG.035(a)(5).

(f) Tables 2 and 3 provide examples of another presentation of VDR matrices identifying sources of validation data for an abbreviated list of tests along with detailed information for a typical test case. In this example, certain data elements have been substituted with 'XX'. A complete matrix should address all test conditions. A complete set of detailed information pages for tests quoted in the matrix would be provided with this presentation.

(g) Tables 4 and 5 provide imaginary example excerpts of VDR matrices to support fidelity levels R and G.

(h) Appendix F to the ARINC 450 document ‘Flight Simulation Training Device Design & Performance Data Requirements’ provides additional examples, illustrating the type of aircraft and avionics configuration information and descriptive engineering rationale used to describe data anomalies, provide alternative data, or provide an acceptable basis to the competent authority for obtaining deviations from objective test validation requirements.

Table 1. Validation Data Roadmap example

			Validation source				Validation document								
ICAO/ IATA#	**Test description**	**CCA mode** *N — Normal law, D — Direct law*	**Aeroplane 1 flight test data**	**Aeroplane 2 flight test data**	**Engineering simulation data** *(Aeroplane 2 with DEF-74 engines)*	**Aerodynamics POM**	**Flight controls POM**	**Ground handling POM**	**Propulsion POM**	**Integrated POM**	**Aeroplane 2 Integrated validation data**	**Aeroplane 2 Validation data roadmap (integrated)**	**Validation source category**	**Rationales** *R — Rationale page attached*	**Comments** *(This VDR is for aeroplane 2 with DEF-74 engines)*
1.a.1	Minimum radius turn.	N		2				NE					FT		
1.a.2	Rate of turn versus nosewheel steering angle (2 speeds).	N			3						D73		ES		
1.b.1	Ground acceleration time and distance.	N			3							D74	ES		Data is included in normal take-off (1.b 4).
1.b.2	Minimum control speed, ground (V_{mcg}).	N		1		d74				D74			FT		
1.b.3	Minimum unstick speed (V_{mu}).	N			3							D74	ES		
1.b.4	Normal take-off.	N	2		3	c78						D74	ES	R	
1.b.5	Critical engine failure on take-off.	N		1		D74							FT		
1.b.6	Crosswind take-off.	N		1		D74							FT		
1.b.7	Rejected take-off.	N		1	3	D74						D74	FT/ES	R	Test procedure anomaly; see rationale.
1.b.8	Dynamic engine failure after take-off.	N		1		d74				D74			FT		
1.c.1	Normal climb all engines operating.	N,D	2		3	d73						D74	ES	R	FT data flown in direct mode; see rationale.
1.c.2	One-engine-inoperative 2nd segment climb.	N		1		D74							FT		AFM data available for reference.
1.c.3	One-engine-inoperative en-route climb.	N			3							D74	ES		
1.c.4	One-engine-inoperative approach climb.	N			3							D74	ES		Run with and without icing accountability.
1.d.1	Level flight acceleration.	N	2		3	C78						D74	FT/ES	R	FSTD manufacturer to evaluate use of FT in QTG.
1.d.2	Level flight deceleration.	N	2		3	C78						D74	FT/ES	R	FSTD manufacturer to evaluate use of FT in QTG.
1.d.3	Cruise performance.	N			3							D74	ES		
1.d.4	Idle descent.	N			3						D73		ES		
1.d.5	Emergency descent.	N			3						D73		ES		

Table 2. Recommended Qualification Test Guide example

QTG	Test description	CCA mode	Validation source				QTG — Natural/computer controlled aeroplane Doc. xxxx Common tests	QTG — Natural/computer controlled aeroplane Doc. xxxx A3xx-xxx — Engine specific tests	Performance test cases for FSTD Doc. xxxx	Autopilot tests Doc. xxxx	Engine tests for FSTD qualification Doc. xxxx	Static control and dynamic control checks Doc. xxxx	Brake static and dynamic control checks Doc. xxxx	Common sound QTG: xxxx	Engine specific sound QTG: xxxx	Common vibration QTG: xxxx	Engine specific vibration QTG: xxxx	Long range flight controls latency tests Doc. xxxx
	A = Engine 1: xx kN. B = Engine 2: xx kN. D: *Direct law.* N: *Normal law.* Alt: *Alternate law or system alternate conditions (e.g. hydraulics off).*		Aeroplane flight test	Proof of match (POM)	Engineering simulator test	AFM data												
1.a.1	Minimum radius turn.	N	B				X											
1.a.2.1	Rate of turn versus nosewheel steering angle — Speed 1.	D	A	A			X											
1.a.2.2	Rate of turn versus nosewheel steering angle — Speed 2.	D	A	A			X											
1.b.1	Ground acceleration time and distance.	N	B	B				X										
1.b.2	Minimum control speed, ground (V_{mcg}).	D			B			X										
1.b.3	Minimum unstick speed (V_{mu}).	D	A	B			X											

Table 3. Recommended Qualification Test Guide example

1. PERFORMANCE	**1.a TAXI**	**1.a.2 Rate of turn versus nosewheel steering angle (NWA)**	**Conditions: Ground**

A — Requirements

Document:	ICAO Doc 9625 — *Manual of Criteria for the Qualification of Flight Simulation Training Devices*, Volume I — *Aeroplanes,* Fourth Edition.
Tolerance:	±2°/s or ±10% of turn rate.
Flight Condition:	Ground.
Comments:	Plot a minimum of two speeds, greater than minimum turning radius speed, with a spread of at least 5 kt ground speed.

Type:	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**
					✓		✓

B — Data Package

Configuration:	**#**	**Avionics 1**	**FCSC**	**FADEC**	**BSCU**	**Flight test validation data**	**Engineering simulation validation data**	**Proof of match**
	1	Std xx	Std xx	Std xx	Std xx	XXXXXX Engine		
	2	Std xx	Std xx	Std xx	Std xx			XXXXXX Engine
	3							
	4							
	5							
	6							

Rationales:	#	
	1	Rationale 1.
	2	Rationale 2.
	3	
	4	
	5	
	6	

Table 4. Imaginary VDR excerpts for an FSTD with the features 'Flight Control Forces and Hardware' and 'Flight Control Systems Operation' simulating a Boeing B747 at Representative (R) fidelity levels

Test No	**Test name**	**Validation data source**				**Additional information on the validation data source.** Detailed justification is presented in the Engineering Report.
		Flight test data	AFM	Public domain data	Subj devel	
2.a.1	Pitch controller position versus force and surface position calibration	✓		✓		Data is from NASA Document ID 19730001300 which shows a measurement from a real B747 aircraft.
2.a.2	Roll controller position versus force and surface position calibration	✓		✓		Data is from NASA Document ID 19730001300 which shows a measurement from a real B747 aircraft.
2.a.3	Rudder pedal position versus force and surface position calibration	✓		✓		Data is from NASA Document ID 19730001300 which shows a measurement from a real B747 aircraft.
2.a.4	Nosewheel steering controller force and position calibration	✓				FSTD manufacturer's measurement in real B747-400 aircraft (registration OH-YES).
2.a.5	Rudder pedal steering calibration		✓		✓	Data for max deflection is from Boeing B747-400 FCOM (Document Number D6-30151-400, revision 21) section 14.10.3. Intermediate positions are validated subjectively.
2.a.8	Alignment of cockpit throttle lever versus selected engine parameter		✓	✓	✓	Engine N1 for go-around and max climb are from Boeing B747-400 FCOM (Document Number D6-30151-400, revision 21) section PI.10.11. Engine idle parameters (N1, N2, FF) are from DFDR data in Japan Transport Safety Board report AI2011-5 Figure 2. Other throttle positions are interpolated between these and are validated subjectively.

Table 5. Imaginary VDR excerpts for an FSTD with the feature 'Performance and Handling Out Of Ground Effect' simulating a single-engine piston aeroplane at Generic (G) fidelity level

Test No	**Test name**	**Validation data source**					**Additional information on the validation data source.** Detailed justification is presented in the Engineering Report.
		Flight test data	AFM	Public domain data	CS-23	Subj devel	
2.c.8	Approach-to-stall characteristics for 2nd segment climb (normal climb and power-on stall event), cruise (straight and turning flight) and landing	✓	✓				FSTD manufacturer's flight test in real aircraft (Cessna 172, registration PH-ISH) for time-history data for all test cases. Stall speed data also validated by Cessna 172 AFM data.
2.c.9	Phugoid dynamics			✓			Time-history data from NASA Document ID 19660030615 Figure 19b.
2.c.10	Short period dynamics				✓	✓	Footprint method is used. Subjective development was performed to fulfil requirements in CS 23.2145 for stability.
2.d.1	Minimum control speed, air (Vmca)						Not applicable to a single engine aircraft. See rationale #2.
2.d.2	Roll response rate				✓	✓	Footprint method is used. Subjective development was performed to fulfil requirements in CS 23.157 for roll rate.

CS FSTD.ENG.030 Alternate engines or avionics validation data

This CS defines the standards for additional/alternate engines or avionics validation data.

(a) Background

(1) For a new aircraft type, the majority of flight validation data is collected on the first aircraft configuration with a 'baseline' engine fit and a 'baseline' avionics configuration which forms the basis of the models and the data pack. This dataset is then used to validate all FSTDs simulating that aircraft type.

(2) In the case of FSTDs simulating an aircraft with a different engine fit from the baseline, or with a revised avionics configuration or more than one avionics configuration, additional flight test validation data may be needed.

(3) When a FSTD with multiple engine fits is to be qualified, the MQTG shall contain test validation data for selected cases where engine differences are expected to be significant.

(4) When an FSTD with alternate avionics configurations is to be qualified, the MQTG shall contain test validation data for selected cases where the avionics configuration differences are expected to be significant as defined in paragraph (c) of this CS.

(5) The nature of the required complementary validation data (e.g. flight test data, engineering simulator data) shall be in accordance with the guidelines prescribed in paragraph (d) of this CS, except where other data is specifically allowed (see CS FSTD.ENG.040).

(b) Validation data requirement for alternate engine fits and alternate avionics configurations

(1) For tests that are affected by difference in engine type or thrust rating, flight test data is preferred to validate that particular aircraft-engine configuration or the alternate thrust rating.

(2) Tests that are significantly affected by a change to the avionics configuration shall be supported by flight test data.

(3) A matrix or VDR shall be provided with the MQTG indicating the appropriate validation data source for each test (see CS FSTD.ENG.025). The organisation requesting qualification shall coordinate FSTD data requirements pertaining to alternate engines or avionics configurations in advance with the competent authority.

GM1 CS FSTD.ENG.030 Objective test standards for the qualification of alternate engines

(a) The following guidance applies to FSTDs equipped with multiple engine types or thrust ratings. Examples are provided for aeroplane FSTDs, but similar principles can be applied to helicopter FSTDs.

(b) To validate additional engine types or thrust ratings in an FSTD, a subset of the QTG should be provided. The test conditions (one per test number) in Table 1 of this CS should be included in that subset, as a minimum.

(c) When the additional engine fit is a different type, all the tests under the additional engine type column in Table 1 of this CS should be provided in the QTG.

(d) In the case where the additional engine type is the same, but the thrust rating exceeds that of the baseline engine fit by 5% or more, or is significantly less than the baseline engine rating (a decrease of 15% or more), all the tests in the additional engine rating column should be provided in the QTG. Otherwise, it might be acceptable to only provide the throttle calibration data (i.e. commanded power setting parameter versus throttle lever angle), and the engine acceleration and deceleration cases. However, if a validation data provider, as defined under the guidelines of CS FSTD.ENG.040, shows that a thrust increase greater than 5% will not significantly change the aircraft's flight characteristics, then flight validation data is not needed.

(e) Sound system and alternate engine fits: For FSTDs with multiple propulsion configurations, any condition listed in the table of objective tests that is identified by the data provider as significantly different due to a change in engine model, should be presented for evaluation as part of the QTG.

(f) If certification of the flight characteristics of the aircraft with a new thrust rating (regardless of thrust rating percentage change) requires certification flight testing with a comprehensive stability and control flight instrumentation package, the VDR should provide a list of objective tests to be supported by flight test data and presented in the QTG (along with additional tests listed in Table 1 of this GM for which other sources of validation data are acceptable).

Table 1. Minimum recommended list of objective tests for an additional engine configuration

Test		Additional engine type	Additional engine rating (exceeds +5% to -15% change from baseline)	Additional engine rating (within +5% to -15% change from baseline)
1.b.1	Ground acceleration time and distance.	X		
1.b.4	Normal take-off	X		
1.b.2	Minimum control speed, ground (V_{mcg}).	X	X	
1.b.5	Critical engine failure on take-off.	X		
1.b.7	Rejected take-off.	X		
1.b.8	Dynamic engine failure after take-off.	X		
1.c.1	Normal climb all engines operating.	X	X	
1.c.2	One-engine-inoperative 2nd segment climb.	X	X	
1.d.1	Level flight acceleration.	X		
1.d.2	Level flight deceleration.	X		

1.d.3	Cruise performance.	X		
1.f.1	Engine acceleration.	X	X	X
1.f.2	Engine deceleration.	X	X	X
2.a.8	Alignment of cockpit throttle lever versus selected engine parameter (throttle calibration).	X	X	X
2.c.1	Power change dynamics.	X	X	
2.d.1	Minimum control speed, air (V_{mca}).	X	X	
2.d.5	Engine-inoperative trim.	X		
2.e.4	One-engine-inoperative landing.	X	X	
2.e.6	All-engine autopilot go-around.	X	X	
2.e.7	One-engine-inoperative go-around.	X	X	
2.e.8	Directional control with reverse thrust (symmetric).	X		
2.e.9	Directional control with reverse thrust (asymmetric).	X		
3.f.1	Thrust effects with brakes set.	X		
5.a.3	All engines at maximum allowable thrust with brakes set.	X		

GM1 CS FSTD.ENG.030 Objective test standards for the qualification of alternate avionics

(a) The following guidance applies to FSTDs simulating aircraft with a revised avionics configuration or more than one avionics configuration.

(b) The aircraft avionics can be segmented into those systems or components that can significantly affect the objective test results and those that cannot. The following avionics systems or components are examples of those for which hardware design changes or software revision updates may lead to significant differences relative to the baseline avionics configuration: flight control computers; controllers for engines; autopilot. braking system; nosewheel steering system; high-lift system; and landing gear system. Related avionics such as stall warning and stability augmentation systems should also be considered. The data provider should identify the objective tests and effects associated with each avionics system change.

(c) For changes to an avionics system or component that could affect an objective test, but where that test is not affected by this particular change (e.g. the avionics change is a BITE update or a modification affecting a different flight phase), the objective test can be based on validation data from the previously validated avionics configuration. The organisation requesting qualification of an FSTD should provide a statement from the aircraft manufacturer clearly stating that this avionics change does not affect the test.

(d) For an avionics change that affects some tests in the QTG, but where no new functionality is added and the impact of the avionics change on the aircraft response is a small, well-understood effect, the QTG may be based on validation data from the previously validated avionics configuration. This should be supplemented with avionics-specific validation data from the aircraft manufacturer's engineering simulation generated with the revised avionics configuration. In such cases, the organisation requesting qualification should provide a rationale from the aircraft manufacturer explaining the nature of the change and its effect on the aircraft response.

(e) For an avionics change that significantly affects some tests in the QTG, especially where a new functionality is added, the QTG should be based on validation data from the previously validated avionics configuration and supplemental avionics-specific test data necessary to validate the alternate avionics revision. However, additional flight validation data may not be needed if the avionics changes were certified without need for testing with a comprehensive flight instrumentation package. In this situation, the organisation operating FSTDs should coordinate FSTD data requirements in advance with the aircraft manufacturer and then with the competent authority.

(f) For changes to an avionics system or component that are non-contributory to objective test response, the test can be based on validation data from the previously validated avionics configuration. For such changes, it is not necessary to include a rationale that this avionics change does not affect the test.

CS FSTD.ENG.035 Applicability to existing FSTD data packages

This CS defines the applicability of CS-FSTD amendments to existing FSTD data packages for FSTDs previously qualified.

(a) General policy

(1) Except where specifically implied otherwise in CS FSTD.QTG.105, validation data for qualification test guide (QTG) objective tests is expected to be derived from aircraft flight testing.

(2) Ideally, data packages for all new FSTDs shall fully comply with the current standards for qualifying FSTDs.

(3) For types of aircraft first entering into service after the publication of a new amendment of CS-FSTD, the provision of acceptable data to support the FSTD qualification process is a matter of planning and regulatory agreement.

(4) For aircraft certified prior to the applicability date of the current amendment of this Certification Specification (CS-FSTD), it may not always be possible to provide the required data for any new or revised objective test cases compared to the previous primary reference documents. After certification, manufacturers do not normally keep flight test aircraft available with the required instrumentation to gather additional data. In the case of flight test data gathered by independent data providers, it is most unlikely that the test aircraft will still be available.

(5) Notwithstanding the above discussion, except where other types of data are already acceptable (see, for example, CS FSTD.QTG.040), the preferred source of validation data is flight testing. It is expected that best endeavours will be made by data

providers to provide the required flight test data. If any flight test data exists (flown during the certification or any other flight test campaigns) that addresses the requirement, this test data shall be provided. If any possibility exists to do this flight test during the occasion of a new flight test campaign, this shall be done and provided in the data package at the next issue. Where this flight test data is genuinely not available, alternative sources of data may be acceptable using the following hierarchy of preferences:

(i) As defined in flight testing at an alternate but near equivalent condition/configuration.

(ii) Data from an engineering simulation as defined in CS FSTD.GEN.015 'Terminology' from an acceptable source (for example, the data meets the guidelines laid out in CS FSTD.ENG.040), or as used for aircraft certification.

(iii) Aircraft performance data as defined in CS FSTD.GEN.015 or other approved published sources (e.g. production flight test schedule) for the following tests:

(A) For aeroplanes:

(a) 1.c.1, Normal climb, all engines;

(b) 1.c.2, One-engine-inoperative 2nd segment climb;

(c) 1.c.3, One-engine-inoperative en-route climb;

(d) 1.c.4, One-engine-inoperative approach climb for aeroplanes with icing accountability;

(e) 1.e.3, Stopping distance, wheel brakes, wet runway, and test; and

(f) 1.e.4, Stopping distance, wheel brakes, icy runway.

(B) For rotorcraft:

(a) 1.d, Hover performance (IGE, OGE); and

(b) 1.g, Climb performance (AEO, OEI);

(iv) Where no other data is available, the following sources may be acceptable subject to a case-by-case review with the competent authorities concerned taking into consideration the FCS sought for the FSTD. For fidelity level S, these sources shall be used in exceptional circumstances only.

(A) Unpublished but acceptable sources e.g. calculations, simulations, video or other simple means of flight test analysis or recording; or

(B) Footprint Data from the actual training FSTD requiring qualification, validated by subjective assessment by a pilot acceptable to the competent authority. Only when all other alternative possible sources of data have been thoroughly sought without success, may Footprint Data be acceptable, subject to a case-by-case review with the competent authority concerned taking into consideration the level of qualification or FCS sought for the FSTD.

Wherever practical, FSTD Footprint Data shall be compared against objectively-validated test cases. For example, if an existing data package contains flight test data for normal take-off but does not contain crosswind take-off data, the organisation requesting qualification could run a crosswind take-off in the FSTD and apply CT&M methodology to compare against the validation flight test data for normal take-off, providing a justification for the differences in control inputs induced by the crosswind.

(6) In certain cases, it may make good engineering sense to provide more than one test to support a particular objective test requirement. An example is a minimum control speed (ground) test (Vmcg) for multi-engine aeroplanes, where the flight test engine and thrust profile do not match the simulated engine. The Vmcg test could be run twice, once with the flight test thrust profile as an input and a second time with a fully integrated response to a fuel cut on the simulated engine.

(7) For aircraft certified prior to the date of issue of the current CS-FSTD, an operator may, after reasonable attempts have failed to obtain suitable flight test data, indicate in the QTG or VDR where flight test data is unavailable or unsuitable for a particular test. For each case, where the preferred data is unavailable, a rationale shall be provided laying out the reasons for the non-compliance and justifying the alternate data and or test(s).

(8) It should be recognised that there may come a time when there is so little compatible flight test data available that new flight testing may be required.

CS FSTD.ENG.040 Engineering simulator validation data

This CS defines the procedures for engineering simulator validation data.

(a) When a fully flight test validation simulation is modified as a result of changes to the simulated aircraft configuration, an aircraft manufacturer may choose, with the prior agreement of the competent authority, to supply validation data from an engineering simulator/simulation to selectively supplement flight test data.

This arrangement is confined to changes that are incremental in nature and that are both easily understood and well defined.

(b) To supply engineering simulator validation data, an aircraft manufacturer shall:

(1) have a proven track record of developing successful data packages;

(2) have demonstrated high-quality prediction methods through comparisons of predicted and flight test validated data;

(3) have an engineering simulator that:

(i) has models that run in an integrated manner;

(ii) uses the same models as released to the training community (which are also used to produce stand-alone proof-of-match and checkout documents); and

(iii) is used to support aircraft development and certification;

(4) use the engineering simulation to produce an adequate set of integrated proof-of-match cases; and

(5) have an effective configuration control system in place covering the engineering simulator and all other relevant engineering simulations.

(c) Aircraft manufacturers seeking to take advantage of this arrangement shall contact the competent authority at the earliest opportunity. The use of engineering simulator validation data is subject to the review and concurrence of the competent authority.

(d) Validation data from an audited engineering simulation may be used for changes that are incremental in nature and which are both easily understood and well defined.

(e) To be admissible as a source of validation data, an engineering simulator shall:

(1) have to exist as a physical entity, complete with a flight deck characteristic of the simulated aircraft, with controls sufficient for manual flight;

(2) have a visual system and preferably also a motion system;

(3) where appropriate, have actual avionics boxes interchangeable with the equivalent software simulations, to support validation of released software;

(4) have a rigorous configuration control system covering hardware and software; and

(5) have been found to be a high-fidelity simulation of the aircraft by the pilots of the manufacturers, operators and the competent authority.

GM1 CS FSTD.ENG.040 Engineering simulator validation data

(a) Background

(1) In the case of fully flight test validated simulation models of a new or major derivative aircraft, it is likely that these models will progressively become less characteristic of the simulated aircraft as the aircraft configuration is revised.

(2) Traditionally, as the aircraft configuration has been revised, the simulation models have been revised to reflect changes. In the case of aerodynamic, engine, flight control and ground handling models, this revision process normally results in the collection of additional flight test data and the subsequent release of new models and validation data.

(3) The quality of the prediction of simulation models has advanced to the point where differences between the predicted and the flight test validation models are often quite small.

(4) Some aircraft manufacturers utilise the same simulation models in their engineering simulations as released to the training community. These simulations vary from physical engineering simulators with and without aircraft hardware to non-real-time workstation-based simulations.

(b) Guidance on implementing engineering simulator validation data

(1) Flight test data should be the primary data source, and engineering simulator validation data should be used only where necessary and justified by a rationale in the VDR.

(2) When a fully flight test-validated simulation is modified as a result of changes to the simulated aircraft configuration, a qualified aircraft manufacturer may choose, with prior agreement of the competent authority, to supply validation data from an engineering simulator/simulation to selectively supplement flight test data.

(3) In cases where data from an engineering simulator is used, the engineering simulation process may be audited in coordination by the Agency.

(4) In all cases, a data package verified to current standards against flight testing should be developed for the aircraft entry-into-service configuration of the baseline aircraft.

(5) Where engineering simulator data is used as validation data to an objective FSTD test, an essential match is expected.

(6) In cases where the use of engineering simulator data is envisaged, a complete proposal should be presented to the competent authority. Such a proposal should contain evidence of the aircraft manufacturer's past achievements in high-fidelity modelling.

(7) A configuration management process should be maintained, including an audit trail which clearly defines the simulation model changes step by step away from a fully flight-validated simulation, so that it would be possible to remove the changes and return to the baseline (flight test validated) version.

(8) The competent authority should conduct technical reviews of the proposed plan and the subsequent validation data to establish acceptability of the proposal.

(9) Implementation of engineering simulators used to produce only system data may not need all the above elements.

(10) The precise procedure followed to use engineering simulator data will vary from case to case between aircraft manufacturers and type of change. The process should be applicable to one step away from a fully flight-validated simulation. Irrespective of the solution proposed, engineering simulations/simulators should conform to the following criteria:

(i) the original (baseline) simulation models should have been fully flight test validated;

(ii) the models as released by the aircraft manufacturer to the industry for use in training FSTDs should be essentially identical to those used by the aircraft manufacturer in their engineering simulations/simulators; and

(iii) these engineering simulation/simulators should have been used as part of the aircraft design, development and certification process.

(11) The type of modifications covered by this alternative procedure will be restricted to those with well-understood effects, such as:

(i) software (e.g. flight control computer, autopilot, etc.);

(ii) simple (in aerodynamic terms) geometric revisions (e.g. body length);

(iii) engines – limited to non-propeller-driven aircraft;

(iv) control system gearing/rigging/deflection limits; and

(v) brake, tyre and steering revisions.

(12) The organisation requesting qualification of an FSTD, with the assistance of the aircraft manufacturer, that wishes to take advantage of this alternative procedure, is expected to demonstrate a sound engineering basis for the proposed approach. Such a sound engineering basis should include an analysis that should show that the predicted effects of the change(s) were incremental in nature and both easily understood and well-defined, confirming that additional flight test data was not required. In the event

that the predicted effects are not deemed to be sufficiently accurate, it might be necessary to collect a limited set of flight test data to validate the predicted increments.

(13) Any applications for this procedure should be reviewed by the Agency.

CS FSTD.ENG.050 Computer controlled aeroplanes

This CS defines requirements concerning computer controlled aeroplane (CCA) FSTDs where the associated aircraft features are at Specific fidelity levels.

(a) For the objective testing of computer controlled aeroplane (CCA) FSTDs, flight test data are required for both the normal and non-normal control states, as applicable to the aeroplane simulated and, as indicated in the objective test requirements. Tests in the non-normal state shall always include the least augmented state. Tests for other levels of control state degradation may be required as detailed by the competent authority at the time of definition of a set of aeroplane tests for FSTD data. Where applicable, flight test data shall record:

(1) pilot controller deflections or electronically generated inputs including location of input; and

(2) flight control surface positions unless test results are not affected by, or are independent of, surface positions.

(b) The recording requirements of (a)(1) and (a)(2) above apply to both normal and non-normal states. All tests in the table of validation tests require test results in the normal control state unless specifically noted otherwise in the comments section following the computer-controlled aeroplane designation (CCA). However, if the test results are independent of control state, non-normal control data may be substituted.

(c) Where non-normal control states are required, test data shall be provided for one or more non-normal control states including the least augmented state.

(d) Where normal, non-normal or other degraded control states are not applicable to the aeroplane being simulated, appropriate rationales shall be included in the Validation Data Roadmap (VDR).

SUBPART D - OBJECTIVE TESTS

GENERAL

CS FSTD.QTG.001 General

(a) The FSTD features shall be validated with objective tests for the proposed FCS.

(i) Each objective test shall compare the performance and system operation of the FSTD against the validation data as described in Subpart C for the particular test, unless specifically noted otherwise (e.g. certain motion, visual and sound objective tests).

(ii) Each objective test shall match the validation data within the limits of the prescribed tolerances of the test.

(b) Each objective test shall establish the FSTD performance and system operation to be used by the FSTD operator as the ongoing recurrent objective testing validation basis for maintaining the FSTD qualification.

CS FSTD.QTG.005 Definition of Applicable Objective Tests for FSTD

(a) The tables of objective tests defined in all CS FSTD.QTG.A or CS FSTD.QTG.H sections shall be used to determine the applicable tests to be included in the QTG and the tolerances applicable for each test. This is based on the fidelity level of each feature in the proposed FCS.

(b) The tables of objective tests define for each test, the FSTD feature(s) that are primarily validated by each tolerance parameter. If the FSTD feature(s) primarily validated by any of the toleranced parameters for a test are simulated on the FSTD at a fidelity level where a tolerance is specified in the 'Tolerances' column, the test is applicable to the FSTD and shall be included in the QTG.

(i) The tolerances applicable to the test are those defined for the FCS fidelity level of the FSTD 'Primary Feature(s) Validated' for each 'Tolerance Parameter'.

(ii) Where a 'Tolerance Parameter' is validated by more than one primary feature (GND, IGE, OGE), the tolerances applicable shall be those defined for the fidelity level of each phase of flight.

(c) The primary feature(s) validated by a test as defined in the tables of objective tests is dependent on other FSTD features being modelled to a sufficient level of simulation detail to support validation of the primary feature(s) fidelity level.

(i) In the case where FSTD features that interact and contribute to an objective test result are simulated at the same fidelity level, the test shall be within the applicable tolerances.

(ii) In the case where FSTD features that interact and contribute to an objective test result are simulated at lower fidelity levels, the simulation detail may not be sufficient to achieve an objective test result within the applicable tolerances. In such cases, the simulation of those supporting features shall be enhanced (e.g. through the use of higher fidelity design data, or enhanced simulation etc.) to improve the objective test result to be within the applicable tolerances. Note that enhancement of an FSTD feature will not affect the FCS unless all requirements for the higher fidelity level of the enhanced feature are met.

(d) An individual test shall be provided in the QTG for each of the test conditions defined in the tables of objective tests for applicable tests.

(i) Where a test is required, but the test cannot be conducted on the FSTD due FSTD features not being simulated (fidelity level N) that are needed to meet other requirements such as Test Conditions, a Statement of Justification (SOJ) shall be provided to explain the non-applicability.

(e) Additional requirements for individual objective tests or a section of objective tests (e.g. take-offs) if applicable, are defined in tables in each CS FSTD.QTG.A or CS FSTD.QTG.H section of objective tests. These shall be reviewed and demonstrated in the relevant individual objective tests.

(f) The ESL and SOJs for the General Requirements (Subpart B) shall be reviewed against the simulated aircraft and FSTD configurations, avionics, engine type/ratings, etc. to ensure that the appropriate objective tests, consistent with the content of the ESL and SOJs, are provided in the QTG to validate the FSTD.

(g) Each objective test shall use the applicable validation data defined in the VDR (see Subpart C).

(h) This subpart defines the objective tests for aeroplanes and rotorcraft. Certain aircraft categories (e.g. tilt rotor aircraft) have characteristics of both aeroplanes and rotorcraft. Therefore, when applicable, the QTG shall include the applicable objective tests for aeroplanes or rotorcraft.

(i) Certain aircraft types may have new technologies or characteristics (e.g. fly-by-wire helicopter) that are not directly considered in this CS-FSTD. In such cases, the list of applicable objective tests may differ from this CS-FSTD and could include additional objective tests to validate aspects not directly considered in this CS-FSTD. This shall be agreed with the competent authority as part of the VDR (see Subpart C).

GM1 CS FSTD.QTG.005 Definition of Applicable Objective Tests

(a) To determine if an objective test is applicable for an FSTD, the tables of objective tests defined in all CS FSTD.QTG.A or CS FSTD.QTG.H sections should be reviewed using the following guidance for each test:

(1) Refer to the 'Tolerance Parameter' column of the test;

(i) For each tolerance parameter stated in the test, note the FSTD feature(s) defined in the 'Primary Feature(s) Validated' column.

(2) Note the fidelity level of the same FSTD feature(s) in the proposed FCS for the FSTD.

(3) Refer to the 'Tolerances' column of the test;

(i) If a tolerance is specified for the fidelity level of the feature(s) in the FSTD proposed FCS, the test is applicable to the FSTD and should be included in the QTG.

(ii) The tolerances applicable to the test are those specified for the fidelity level of the FSTD feature(s) primarily validated.

(b) The following examples provide guidance on the use of the tables of objective tests to define test and tolerance applicability for an FSTD:

(1) Rotorcraft FSTD with feature OGE at fidelity level S:

(i) As per CS FSTD.QTG.H.120, 1.e, the test is applicable to the FSTD and must be included in the QTG as tolerances are specified in the 'Tolerances' column for Vertical velocity, Direction control position or blade angle, and Collective control position of blade angle.

(ii) Vertical velocity, Direction control position or blade angle, and Collective control position of blade angle must have the relevant tolerances defined for fidelity level S applied to each parameter.

(iii) The relevant numerical tolerances defined for 'Init' must be applied to each parameter for the initial qualification. An Essential Match of each parameter as defined for 'Rec' is expected for recurrent testing.

(2) Aeroplane FSTD with features GND at fidelity level R, IGE at fidelity level S, and simulating an aircraft without reversible flight controls :

(i) As per CS FSTD.QTG.A.105, 1.b.4, the test is applicable to the FSTD and must be included in the QTG as tolerances are specified in the 'Tolerances' column for Airspeed, Pitch angle, AoA, Height and Column Force.

(ii) Airspeed, Pitch angle, AoA and Height must have the relevant tolerances defined for fidelity level S applied to each parameter.

(iii) The Column force tolerance is not applicable as the aircraft simulated does not have reversible flight controls.

(iv) The CT&M tolerance defined for fidelity level R 'Init' must be applied to Airspeed, Pitch angle, AoA and Height for the portion of the test conducted on ground, and the relevant numerical tolerances defined for fidelity level S for 'Init' must be applied to each parameter for the portion of the test conducted in ground effect. An Essential Match of each parameter as defined for fidelity levels R and S 'Rec' is expected for recurrent testing.

(3) Aeroplane FSTD with features CLO and CLH at fidelity level R, and feature GND not simulated (fidelity level N):

(i) As per CS FSTD.QTG.A.200, 2.a.9, the test is applicable to the FSTD and must be included in the MQTG as tolerances are specified in the 'Tolerances' column for Force and Brake system pressure.

(ii) The test cannot be conducted on the FSTD as the lack of GND feature would mean that the requirement of conducting the test in the Ground Test Condition cannot be met.

(iii) This should be explained in a Statement of Justification.

(c) If an objective test is required, but is not applicable to the simulated aircraft, the test should still be included in the list of applicable objective tests and a Statement of Justification provided in QTG to explain why the test cannot be conducted on the FSTD. For example:

(1) An FSTD simulating a single engine aeroplane cannot meet the requirements for one engine inoperative objective tests.

(2) An autopilot landing test is applicable only to FSTDs with appropriate autoland capability.

(d) This subpart defines the objective tests for aeroplanes and rotorcraft. Certain aircraft categories (e.g. tilt rotor aircraft) have characteristics of both aeroplanes and rotorcraft. Therefore, when applicable, the QTG should include the applicable objective tests for aeroplanes or rotorcraft.

(e) Certain aircraft types may have new technologies or characteristics (e.g. fly-by-wire helicopter) that are not directly considered in this CS-FSTD. In such cases, the list of applicable objective tests may differ from this CS-FSTD and could include additional objective tests to validate aspects not directly considered in this CS-FSTD. This should be agreed with the competent authority as part of the VDR (see Subpart C).

CS FSTD.QTG.010 Objective Test Content

(a) Each objective test in the QTG shall contain sufficient information for the FSTD operator to demonstrate compliance with the applicable requirements of this CS for the test.

(b) The following information shall be provided for each objective test:

(1) Test number: this shall provide a clear link to the numbering defined in the relevant CS FSTD.QTG.A or CS FSTD.QTG.H section.

(2) Test title: this shall be short and definitive, and based on the test title referred to in the relevant CS FSTD.QTG.A or CS FSTD.QTG.H section.

(3) Test objective: this shall be a brief summary of what the test is intended to demonstrate and how the objective is to be met.

(4) References: these are the validation data source documents referred to in the VDR, including both the document number and the page or condition number and other supporting data or information if applicable.

(5) Initial conditions: a full and comprehensive list of the FSTD test initial conditions is required. These conditions shall include the following as a minimum (as applicable to the aircraft simulated):

(i) gross weight,

(ii) moments of inertia (for aeroplanes) and centre of gravity;

(iii) pressure altitude;

(iv) radar altitude or mean gear height above ground*;

(v) airspeed (calibrated, indicated etc., or ground speed when airspeed is not valid, but as specified in the validation data), and vertical speed;

(vi) Pitch, roll and yaw angles (Euler angles);

(vii) landing gear positions;

(viii) outside air temperature;

(ix) wind speed and direction*;

(x) engine power rating selection, fuel flow and bleed condition;

(xi) stability augmentation status (each axis) including the flight control law mode for fly-by-wire aircraft and autopilot state or mode if applicable;

(xii) key engine, propeller and transmission parameters (e.g. N1, EPR, torque, propeller rpm, etc. for aeroplanes; torque, NG, NR, NF, ITT etc. for rotorcraft);

(xiii) primary flight control positions (pitch, roll and yaw) for aeroplanes, rotor blade angles for rotorcraft;

(xiv) for aeroplanes: forces on the primary flight controls (pitch, roll and yaw);

(xv) linear and rotational velocities and accelerations/load factors (each axis);

(xvi) for aeroplanes: secondary flight controls such as leading and trailing edge flap/slat, speedbrake and spoiler positions;

(xvii) for aeroplanes: Mach number (for cruise/high altitude condition);

(xviii) for aeroplanes: trim settings (pitch, roll and yaw).

* denotes extra parameters required for tests performed on or near the ground.

(6) Manual test procedures: they shall clearly describe how the FSTD will be set up and operated for each test when flown manually by a person. Procedures shall be sufficient to enable the test to be flown using reference to flight deck instrumentation only.

(7) Automatic test procedures: they shall describe how to execute the test using an automatic testing system. They shall cover the execution of performance and handling tests, and also motion, visual and sound tests where the automatic testing system may need manual steps to be conducted by the FSTD operator (such as assessment of a visual test pattern) in the process of executing a test.

(8) Information how each test is constructed and how the automatic test system is controlling the test e.g. which parameters are driven through the application of either open or closed loop followers, or locked at a constant fixed value.

(9) Evaluation criteria: specify the applicable tolerances and main parameter(s) under scrutiny during the test.

(10) Any rationales necessary to justify out of tolerance results or to support the use of engineering judgement in the conduct of an objective test.

(11) Validation data: copy of the validation data clearly marked with the document, page number, issuing authority, and the test number and title, and, if necessary, a further definition of the point at which the information was extracted from the validation data source;

(12) Test result and comparison of results: FSTD test result obtained when running the test on the FSTD. The result shall indicate:

(i) the FSTD on which the test was run;

(ii) the software load/version used and other information as necessary to identify the configuration of the FSTD;

(iii) whether the test was run manually or automatically;

(iv) the date and time of the test run;

(v) have each page reflect the test page number and the total number of pages in the test result;

(vi) Assessment of result against evaluation criteria.

(13) Test revision number: this shall define the revision of the test script that conducts the test and generates the test output, and shall serve as the means to demonstrate configuration control of the objective test script.

GM1 CS FSTD.QTG.010 Objective Test Content

(a) Some test content information may not be applicable for certain types of objective test, particularly in the area of motion, sound and visual. As an example, manual test procedures (CS FSTD.QTG.010, para (b)(6) and information on test construct (CS FSTD.QTG.010, para (b)(8) are unlikely to be needed for these types of tests. In these cases, the information may be omitted from the test.

CS FSTD.QTG.015 Objective Test Result Presentation

(a) Initial qualification

(1) Each objective test shall be presented in a form and manner to allow comparison of the FSTD result against the validation data.

(2) Each objective test shall be presented in a form and manner to allow an assessment of the FSTD result against the applicable tolerances.

(3) The initial conditions for each test shall be provided.

(4) To facilitate objective assessment of the FSTD performance and system operation, a recording of the relevant FSTD parameters shall be made for each objective test and presented as time history plots, directly over plotted with the same parameters from the validation data where available.

(5) The following time history plots shall be provided in each objective test;

(i) All toleranced parameters.

(ii) All driven parameters, i.e. the FSTD parameters that are ‘driven’ with corresponding parameters from the validation data in order to execute the test, such as primary and secondary flight control inputs.

(iii) Relevant primary axis parameters to facilitate a review of the FSTD performance, including evidence of end to end testing, for the primary axis of interest throughout the test.

(iv) Sufficient off-axis parameters to confirm the overall FSTD performance, including evidence of end to end testing, throughout the test.

(6) Where an objective test may be provided as a snapshot, it shall be possible to compare the toleranced FSTD snapshot parameters against the corresponding validation data.

(7) The size and scaling of time history plots shall provide the resolution necessary for efficient evaluation and identification of changes in parameter values.

(b) Recurrent test presentation

(1) Where the recurrent test tolerance is specified as 'EM' (Essential Match):

(i) Each objective test shall provide a method of directly comparing the current FSTD result against the MQTG result for recurrent testing to confirm there are no changes in performance from the MQTG, and that an essential match with the MQTG can be achieved for all test parameters.

(ii) Each objective test shall provide a method of directly comparing the current FSTD results against the validation data.

(iii) To facilitate objective assessment of an essential match between the current FSTD result against the MQTG result and to also compare the FSTD result against the validation data, the FSTD result, MQTG result, and validation data shall all be directly over plotted.

(2) Where the recurrent test tolerance is specified as 'Same as init' (Same as for the initial qualification), the requirements of CS FSTD.QTG.015, para (a) apply.

(3) Where an objective test may be provided as a snapshot, it shall be possible to compare the snapshot parameters from the current FSTD result against the MQTG result and also against the validation data.

GM1 CS FSTD.QTG.015 Objective Test Result Presentation

(a) Plotted parameters

(1) As guidance, the following groups of parameters should be considered for inclusion in each performance and handling objective test dependent on flight regime and manoeuvre. The parameters should support the analysis of primary axis, and off-axis FSTD inputs and resulting aircraft performance, if not already provided due to being either toleranced or driven parameters;

(i) Aircraft state parameters – e.g.:

(A) Airspeed/Mach/ground speed, altitude, radio height above ground

(B) Pitch, roll and yaw angles (Euler angles)

(C) Angular/Euler rates

(ii) Flight controls - e.g. control positions and blade angles, surface positions

(iii) Secondary flight controls - e.g. control positions, system outputs

(iv) Configuration parameters – e.g. flaps, gear

(v) Engine key parameters – e.g. engine control positions, output parameters, rotor speed

(vi) Environment parameters – e.g. wind speed and direction

(vii) System parameters – e.g. envelope protection functions, alerts, stick shaker

(2) It is preferable for plotted parameters to be ordered axis by axis - e.g.:

(i) Main flight parameters (speed, altitude, rate of climb, etc.)

(ii) Pitch/longitudinal axis (flight control, angular rates, attitude, etc.)

(iii) Roll/lateral axis (flight control, angular rates, attitude, etc.)

(iv) Yaw/directional axis (flight control, angular rates, attitude, etc.)

(v) Vertical axis (collective, NR, torque, etc.)

(vi) Other parameters added to each section, where needed for the particular test (e.g. sideslip, load factor, angle of attack, etc.)

(b) Tolerance bands

(1) The use of tolerance bands on time history plots to illustrate the upper and lower limits of the applicable tolerances may be used. These should support the initial qualification process of analysing the FSTD result against the validation data.

(c) Presentation of validation data

(1) Aircraft data documents included in the QTG may be photographically reduced only if such reduction will not cause distortions or difficulties in scale interpretation or resolution.

(2) Validation data variables should be defined in a nomenclature list along with sign convention. This list should be included at some appropriate location in the QTG.

(d) In showing compliance with CS FSTD.QB.001 para (c), account should be taken of the ARINC document entitled 'ARINC 436 Guidelines For Electronic Qualification Test Guide'.

CS FSTD.QTG.020 Conducting Objective Tests

(a) Initial qualification

(1) It shall be possible to conduct each performance and handling objective test automatically using an automatic test driver programme by following the automatic test procedure.

(i) Motion, Visual, Sound, and Systems Integration objective tests shall be conducted automatically to the maximum extent possible, with all steps required to be executed manually to complete the test and obtain a test result, defined within the automatic test procedure.

(2) Test inputs used to set up the initial conditions for each test shall show an essential match to the validation data with engineering judgement applied where differences are present.

(3) Performance and handling tests for stabilisation of snapshots and execution of time histories shall be driven automatically through the application of open or closed loop drivers to the relevant pilot control inputs, or by locking certain pilot control inputs to a fixed constant value where appropriate.

(i) Open loop drivers

(A) An open loop driver shall not apply any deviation to the shape, timing and magnitude of the corresponding pilot control input validation data parameter, unless justified by a supporting rationale.

(ii) Closed loop drivers

(A) Use of a closed loop follower on a pilot control input shall only be applied where the corresponding validation data parameter exhibits frequent varying inputs throughout the time history that may integrate throughout the duration of the test into larger errors between the FSTD result and validation data if an open loop driver were used.

(B) A closed loop follower shall not be applied to a tolerance parameter.

(iii) Locked parameters

(A) Some pilot control inputs that do not change throughout the duration of the time history may be locked at the constant fixed value for the duration of the test.

(b) Recurrent testing

(1) All test inputs used to set up the initial conditions for a recurrent test shall be made using the same inputs that were used for the corresponding MQTG result.

(2) All pilot control inputs for a recurrent test shall be made using the same open and closed loop drivers that were used for the corresponding MQTG result.

(c) Manual testing

(1) It shall be possible to run each performance and handling objective test manually by following the manual test procedure.

(2) Performance and handling objective tests shall be capable of being conducted manually from all pilot seats.

(d) Integrated and end to end testing

(1) When executing an objective test, the FSTD test shall be running in the same integrated manner using all FSTD features as it would be when the FSTD is being used in training.

(2) Unless otherwise justified, all pilot control inputs (e.g. primary and other flight controls) needed to execute each performance and handling objective test, for both snapshot and time history tests, shall be made through the relevant pilot controls either manually, or automatically with open or closed loop driver, by the test driver programme.

(e) Tests run on a computer that is independent of the FSTD are not acceptable.

GM1 CS FSTD.QTG.020 Conducting Objective Tests

(a) Initial qualification

(1) Application of open and closed loop drivers and locked parameters

(i) Open loop drivers

(A) Open loop drivers are the preferred type of driver to be used as they ensure the test input is the same as used in the validation data which will lead to a reliable assessment of the test outputs.

(ii) Closed loop drivers

(A) Typically, closed loop drivers should only be applied to highly dynamic tests such as take off and landings. They would not be expected to be applied to the pilot control input in the primary axis for tests such as longitudinal free response tests (power, flap, gear change dynamics etc), and tests where the FSTD performance to a fixed control input is assessed (small control inputs, roll control step input, etc).

(iii) Locked parameters

(A) A pilot control input should only be locked for the duration of a test where it is necessary to ensure no change throughout the test, such as ensuring no change in gear or flap handle.

(b) Recurrent testing

(1) Where the MQTG test result is a 'footprint' result, the recurrent test may use the MQTG result pilot control outputs as open or closed loop driver inputs that are 'driven' into the simulation for the purposes of executing the recurrent test automatically.

(c) Manual testing

(1) When executing a test manually, it should be possible to achieve a result that matches the validation data within the limits of the prescribed tolerances of the test.

(2) Referral to the validation data and/or automatic test results is encouraged for complex tests in order to help guide the manual control inputs.

(d) Integrated and end to end testing

(1) The requirement for objective tests to be executed through the relevant pilot control inputs (known as 'end to end testing') with the FSTD running in an integrated manner (known as 'integrated testing') was created during the development of the ICAO Doc 9625 Manual of Criteria for the Qualification of Flight Simulators, First Edition 1993, by an RAeS Working Group. The following text was inserted in the document:

'It is not the intent, nor is it acceptable, to test each Flight Simulator subsystem independently. Overall Integrated Testing of the Flight Simulator should be accomplished to assure that the total Flight Simulator system meets the prescribed standards.'

(2) Objective tests may be executed without the motion system active only in tests where the motion system is not integral to the objective of the test or does not affect any of the toleranced parameters.

CS FSTD.QTG.025 Assessing Objective Tests

(a) Initial qualification

(1) Each objective test shall be assessed to ensure the FSTD result matches the validation data within the limits of the prescribed tolerances for initial conditions, snapshots, and duration of time histories as applicable to the test.

(i) Some objective tests (e.g. take-offs and landings) span several flight regimes (e.g. ground, in ground effect, and out of ground effect). All toleranced parameters shall remain within the limits of the prescribed tolerances of that feature for the duration of the test.

(ii) Some validation data parameters may exhibit rapid time history variations that require engineering judgement when making assessments of the FSTD result against the validation data. Such judgement shall not be linked to a single parameter. All relevant parameters related to a given manoeuvre or test condition shall be assessed for overall interpretation.

(iii) When it is difficult or impossible to match a validation data parameter in a snapshot or throughout a time history within the limits of the prescribed tolerance, a rationale shall be provided in the QTG detailing the reason for the deviation and why the test result is to be considered acceptable.

(iv) All parameters that are not subject to tolerances shall demonstrate a match to the validation data with any variations comparable to the manoeuvre of the objective test. Significant differences shall be justified in the QTG by a supporting rationale.

(2) Where engineering data or other non-flight test data are used as an allowable form of validation data for a test, the FSTD result shall match the validation data within 40% of the tolerances defined in the relevant CS FSTD.QTG.A or CS FSTD.QTG.H section when the tolerance applicable to the test is due to the primary feature validated being modelled at the Specific (S) level of fidelity.

(3) Where an objective test result is provided as a 'footprint', justification of the footprint shall be made as part of the Engineering Report (see Subpart C).

(b) Recurrent test assessment

(1) Where the recurrent test tolerance is specified as 'EM' (Essential Match):

(i) Each objective test shall be assessed to ensure that an essential match with the MQTG test result has been achieved for all initial conditions parameters, time history plots, and snapshots where applicable.

(2) Where the recurrent test tolerance is specified as 'Same as init' (Same as for the initial qualification), the requirements of CS FSTD.QTG.025, para (a) apply.

GM1 CS FSTD.QTG.025 Assessing Objective Tests

(a) Principles of test inputs affecting test outputs

(1) For any objective test, demonstration that the test inputs used for setting up initial conditions and any further snapshots, or for driving pilot controls either open or

closed loop throughout a time history, show an essential match to the validation data is fundamental in being able to reliably assess the FSTD outputs.

(2) Test inputs required, and FSTD outputs assessed can be varied according to the type of test. Examples of inputs could be aircraft initial configuration, atmospheric conditions and/or primary and other flight control positions for performance and handling tests, particular flight model rates and accelerations for some motion tests, and commands to display a visual test pattern for some visual tests. In each of these examples, the outputs which would be response of the simulated aircraft, or the physical movement of the motion system, or the measured result from the visual test pattern would be assessed against the evaluation criteria for the tests.

(b) Initial qualification

(1) Interpretation of test tolerances:

(i) When two tolerance values are given for a parameter, the less restrictive may be used unless indicated otherwise.

(ii) Where tolerances are expressed as a percentage:

(A) For parameters that have units of percent, or parameters normally displayed in the flight deck in units of percent (e.g. N1, N2, engine torque or power), then a percentage tolerance should be interpreted as an absolute tolerance unless otherwise specified (i.e. for an observation of 50% N1 and a tolerance of 5%, the acceptable range should be from 45% to 55%).

(B) For parameters not displayed in units of percent, a tolerance expressed only as a percentage should be interpreted as the percentage of the current validation data value of that parameter during the test, except for parameters varying around a zero value for which a minimum absolute value should be agreed with the competent authority.

(2) Application of open and closed loop drivers

(i) Open loop drivers

(A) An open loop driver should show an essential match to the shape, timing and magnitude of the pilot control input compared to the corresponding validation data parameter.

(B) Small constant offsets throughout the time history may be acceptable to take account for differences between the FSTD pilot control input and corresponding validation data parameter resulting from the initial trim.

(ii) Closed loop drivers

(A) Application of a closed loop driver should result in the target parameter having a close match to the validation data with the error represented in the pilot control input. Therefore, the control match becomes an important indicator of the FSTD quality, and should only exhibit small differences to the validation data.

(3) Test condition verification

(i) When assessing the parameters listed in initial conditions or snapshots, and time history plots to those of the aeroplane, sufficient parameters should be assessed to verify the correct test condition. For example:

(A) To show the control force is within ± 2.2daN (5 lb) in a static stability test, data to show correct airspeed, power, thrust or torque, aeroplane configuration, altitude, and other appropriate datum identification parameters should also be assessed.

(B) To assess short period dynamics on an FSTD, pitch angle, pitch rate and normal acceleration may be used to establish a match to the aeroplane, but airspeed, altitude, control input, aeroplane configuration, and other appropriate data should also be assessed.

(C) All airspeed values should be assumed to be calibrated unless annotated otherwise and like values used for assessment.

(4) General principles

(i) Test result assessment for initial conditions and any subsequent snapshots should review all parameters presented to ensure they show a good match to the validation data taking into consideration the FCS. The same should be applied for all test results presented as snapshots.

(ii) Test result assessment for time history plots should review all parameters plotted to ensure they show a good match to the validation data taking into consideration the FCS. This should include assessing the FSTD result for all supporting parameters in the primary axis, as well as off-axis parameters, to confirm overall replication of the manoeuvre and implementation of end to end testing.

(c) Recurrent test assessment

(1) An essential match of pilot inputs is of paramount importance for a recurrent test in ensuring that an essential match with the MQTG test result can be achieved. If the recurrent test pilot inputs do not match the MQTG test result pilot inputs, the test should not be considered as compliant with the technical requirements. The reasons for any differences should be investigated and resolved, with the test revised in the MQTG if necessary.

(2) Where the tolerance specified for recurrent test assessment is 'Same as init', then all elements of this subpart that refer to the initial qualification are applicable for recurrent tests.

(d) Manual test assessment

(1) There may be segments of a test result where a parameter(s) is outside the limits of the prescribed tolerance(s). Engineering judgement should be applied to the assessment of the test result taking into consideration aspects such as rapid variations in parameter values as well as the complexity of the pilot's input attempting to be replicated.

(e) The RAeS Aeroplane Flight Simulator Evaluation Handbook, as amended, is a useful source of guidance for objective tests, use of open and closed loop drivers, and flight test validation data including how and when to apply engineering judgement.

GM2 CS FSTD.QTG.025 Engineering Simulator Validation Data Test Tolerances

(a) Use of engineering simulation validation data

(i) There are many reasons why an objective test may not fully match the validation data within the limits of the prescribed tolerances. For example:

(A) a flight test is subject to many sources of potential error, e.g. instrumentation errors and atmospheric disturbance during data collection

(B) data that exhibits rapid variation or noise may also be difficult to match

(C) engineering simulator validation data and other calculated data may exhibit errors due to a variety of potential differences discussed below

(ii) When applying tolerances to any test result, good engineering judgement should be applied. Where a test result clearly falls outside the prescribed tolerance(s) for no acceptable reason, then it should be judged to have failed.

(iii) When engineering simulator validation data is used, the basis for its use is that the validation data is produced using the same simulation models as used in the equivalent FSTD; i.e. the two sets of results should be 'essentially' similar. When engineering simulation validation data is used, it is understood that the flight-test-based tolerances should be reduced since applied tolerances should not include measurement errors inherent to flight test data.

(iv) There are reasons why the FSTD test result would differ when compared against the engineering simulation validation test data. The reasons include, but are not limited to:

(A) hardware (avionics units and flight controls)

(B) modelling solutions used in the FSTD are different from those used by the aircraft original equipment manufacturer (ground handling models, braking models, engine models, etc.);

(C) model cascading effects

(D) iteration rates

(E) execution order

(F) integration methods

(G) processor architecture

(H) digital drift:

(a) interpolation methods

(b) data handling differences

(c) auto-test trim tolerances, etc.

(d) open loop versus closed loop responses

(e) test duration

(f) extent of dependency on contributory aircraft systems adding to the complexity of the test

(g) accuracy of the match of the initial conditions

(v) Any differences between the FSTD test result and the engineering simulation validation data should, however, be small and the reasons for any differences, other than those listed above, should be clearly explained.

(vi) Historically, engineering simulation validation data was used only to demonstrate compliance with certain extra modelling features because:

(A) flight test data could not reasonably be made available

(B) data from engineering simulations made up only a small portion of the overall validation data set

(C) key areas were validated against flight test data

(vii) The current increase in the use and projected use of engineering simulation validation data is an important issue because:

(A) flight test data is often not available due to sound technical reasons

(B) alternative technical solutions are being advanced

(C) cost is an ever-present consideration

(viii) Guidelines are therefore needed for the application of tolerances to engineering-simulator-generated validation data.

OBJECTIVE TESTS FOR AEROPLANES

CS FSTD.QTG.A.100 Performance taxi - Aeroplane

This CS provides standards of the objective tests for aeroplane taxi.

1.a: Performance Taxi		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.a.1	Minimum radius turn	Ground	Aeroplane turn radius	GND		Init: CT&M Rec: EM	Init: ±0.9 m (3 ft) or ±20% Rec: EM
1.a.2	Rate of turn versus nosewheel steering angle	Ground	Turn rate	GND		Init: CT&M Rec: EM	Init: ±10% or ±2°/s Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.a: Performance Taxi		Test requirements
1.a.2	Minimum radius turn	1. Record for a minimum of two speeds, greater than minimum turning radius speed with one at a typical taxi speed, and with a spread of at least 5 kts.
1.a.1	Rate of turn versus nosewheel steering angle	1. Plot both main and nose gear-turning loci and key engine parameter(s). 2. Data for no brakes and the minimum thrust required to maintain a steady turn except for aeroplanes requiring asymmetric thrust or braking to achieve the minimum radius turn.

CS FSTD.QTG.A.105 Performance take-off - Aeroplane

This CS provides standards of the objective tests for aeroplane take-off.

1.b: Performance Take-off		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.b.1	Ground acceleration time and distance	Take-off	Time	GND		Init: ±5% or ±1.5 s Rec: EM	Init: ±5% or ±1.5 s Rec: EM
			Distance	GND		Init: ±5% or ±61 m (200 ft) Rec: EM	Init: ±5% or ±61 m (200 ft) Rec: EM
1.b.2	Minimum control speed, ground (V_{MCG})	Take-off	Maximum aeroplane lateral deviation	GND			Init: ±25% of maximum aeroplane lateral deviation or ±1.5 m (5 ft) Rec: EM
			Additional tolerance parameter for aeroplanes with reversible flight control systems:				
			Rudder pedal force	GND			Init: ±10% or ±2.2 daN (5 lb) Rec: EM
1.b.3	Minimum unstick speed (V_{MU}) or equivalent test	Take-off	Airspeed	GND, IGE			Init: ±3 kts Rec: EM
			Pitch angle	GND, IGE			Init: ±1.5° Rec: EM

1.b: Performance Take-off		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.b.4	Normal take-off	Take-off	Airspeed	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Pitch angle	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			AoA	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			Height	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±6m (20 ft) Rec: EM
			Additional tolerance parameter for aeroplanes with reversible flight control systems:				
			Column force	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% or ±2.2 daN (5 lb) Rec: EM
1.b.5	Critical engine failure on take-off	Take-off	Airspeed	GND, IGE		Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Pitch angle	GND, IGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			AoA	GND, IGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			Height	GND, IGE		Init: CT&M Rec: EM	Init: ±6 m (20 ft) Rec: EM
			Roll angle	GND, IGE		Init: CT&M Rec: EM	Init: ±2° Rec: EM
			Sideslip angle	GND, IGE		Init: CT&M	Init: ±2°

1.b: Performance Take-off		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
						Rec: EM	Rec: EM
			Heading angle	GND, IGE		Init: CT&M Rec: EM	Init: ±3° Rec: EM
			Additional tolerance parameters for aeroplanes with reversible flight control systems:				
			Column force	GND, IGE		Init: CT&M Rec: EM	Init: ±10% or ±2.2 daN (5 lb) Rec: EM
			Wheel force	GND, IGE		Init: CT&M Rec: EM	Init: ±10% or ±1.3 daN (3 lb) Rec: EM
			Rudder pedal force	GND, IGE		Init: CT&M Rec: EM	Init: ±10% or ±2.2 daN (5 lb) Rec: EM
1.b.6	Crosswind take-off	Take-off	Airspeed	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Pitch angle	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			AoA	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			Height	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±6 m (20 ft) Rec: EM
			Roll angle	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2° Rec: EM

1.b: Performance Take-off		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Sideslip angle	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2° Rec: EM
			Heading angle	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3° Rec: EM
			Additional tolerance parameters for aeroplanes with reversible flight control systems:				
			Column force	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% or ±2.2 daN (5 lb) Rec: EM
			Wheel force	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% or ±1.3daN (3 lb) Rec: EM
			Rudder pedal force	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% or ±2.2 daN (5 lb) Rec: EM
1.b.7	Rejected take-off	Take-off	Time	GND	Init: CT&M Rec: EM	Init: ±5% or ±1.5 s Rec: EM	Init: ±5% or ±1.5 s Rec: EM
			Distance	GND	Init: CT&M Rec: EM	Init: ±7.5% or ±76 m (250 ft) Rec: EM	Init: ±7.5% or ±76 m (250 ft) Rec: EM
1.b.8	Dynamic engine failure after take-off	Take-off CCA: Test in normal and non-normal control state	Body angular rates (roll, pitch & yaw)	OGE			Init: ±20% or ±2 deg/s Rec: EM

(a) Requirements for all the aeroplane take-off tests:

1.b: Performance Take-off	Test requirements
All tests	1. For fidelity level R and S: All aeroplane manufacturer commonly used certified take-off flap settings shall be demonstrated at least once either in Minimum unstick speed 1.b.3, Normal take-off 1.b.4, Critical engine failure on take-off 1.b.5 or Crosswind take-off 1.b.6

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.b: Performance Take-off		Test requirements
1.b.1	Ground acceleration time and distance	1. Acceleration time and distance shall be recorded for a minimum of 80% of the total time from brake release to V_R. 2. May be combined with Normal take-off 1.b.4 or Rejected take-off 1.b.7. Plotted data shall be shown using appropriate scales for each portion of the manoeuvre.
1.b.2	Minimum control speed, ground (V_{MCG})	1. Aerodynamic controls shall be only per applicable airworthiness requirement or alternative engine inoperative test to demonstrate ground control characteristics. 2. Engine failure speed shall be within ±1 kts of aeroplane engine failure speed. Engine thrust decay shall be that resulting from the mathematical model for the engine variant applicable to the FSTD under test. If the modelled engine is not the same as the aeroplane manufacturer's flight test engine, a further test may be run with the same initial conditions using the thrust from the flight test data as the driving parameter. To ensure only aerodynamic control, nosewheel steering shall be disabled (i.e. castored) or the nosewheel held slightly off the ground. 3. If a V_{MCG} test is not available, an acceptable alternative is a flight test snap engine deceleration to idle at a speed between V_1 and V_1-10 kts, followed by control of heading using aerodynamic control only and recovery shall be achieved with the main gear on the ground.
1.b.3	Minimum unstick speed (V_{MU}) or equivalent test	1. Purpose is to demonstrate early rotation take-off characteristics. 2. V_{MU} is defined as the minimum speed at which the last main landing gear leaves the ground. Main landing gear strut compression or equivalent air/ground signal shall be recorded. 3. If a V_{MU} test is not available, alternative acceptable flight tests are a constant high-attitude take-off run through main gear lift-off, or an early rotation take-off. 4. If either of these alternative solutions is selected, aft body contact/tail strike protection functionality, if present on the aeroplane, shall be active.

1.b: Performance Take-off		Test requirements
		5. Record time history data from 10 kts before start of rotation until at least 5 s after the occurrence of main gear lift-off.
1.b.4	Normal take-off	1. Data required for near maximum certified take-off weight at mid centre of gravity location and light take-off weight at an aft centre of gravity location. 2. If the aeroplane has more than one certified take-off configuration, a different configuration shall be used for each weight. 3. Record take-off profile from brake release to at least 61 m (200 ft) AGL. 4. The test may be used for Ground acceleration time and distance 1.b.1. 5. Plotted data shall be shown using appropriate scales for each portion of the manoeuvre.
1.b.5	Critical engine failure on take-off	1. Record take-off profile to at least 61 m (200 ft) AGL. 2. Engine failure speed shall be within ±3 kts of the aeroplane data. 3. Test at near maximum take-off weight.
1.b.6	Crosswind take-off	1. Record take-off profile from brake release to at least 61 m (200 ft) AGL. 2. This test requires test data, including wind profile, for a crosswind component of at least 60% of the aeroplane performance data value measured at 10 m (33 ft) above the runway. 3. Wind components shall be provided as headwind and crosswind values with respect to the runway.
1.b.7	Rejected take-off	1. Record near maximum take-off weight. 2. Speed for reject shall be at least 80% of V_1. 3. Autobrakes will be used where applicable. 4. Maximum braking effort, auto or manual. 5. Where a maximum braking demonstration is not available, an acceptable alternative is a test using approximately 80% braking and full reverse, if applicable. 6. Time and distance shall be recorded from brake release to a full stop. 7. For fidelity level G and R: Record time for at least 80% of the time segment from initiation of the rejected take-off to full stop.
1.b.8	Dynamic engine failure after take-off	1. Engine failure speed shall be within ±3 kts of the aeroplane data. 2. Engine failure may be a snap deceleration to idle. 3. Record hands off from 5s before engine failure to +5 s or 30° bank, whichever occurs first.

1.b: Performance Take-off		Test requirements
		4. Note: For safety considerations, aeroplane flight test may be performed out of ground effect at a safe altitude, but with correct aeroplane configuration and airspeed. 5. CCA: Test in normal <u>and</u> non-normal control state.

CS FSTD.QTG.A.110 Performance climb - Aeroplane

This CS provides standards of the objective tests for aeroplane climb performance.

1.c: Performance Climb		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.c.1	Normal climb all engines operating	Clean	Airspeed	OGE	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Rate of climb	OGE	Init: CT&M Rec: EM	Init: ±5% or ±0.5 m/s (100 ft/min) Rec: EM	Init: ±5% or ±0.5 m/s (100 ft/min) Rec: EM
1.c.2	One engine inoperative second segment climb	2nd segment climb	Airspeed	OGE	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Rate of climb	OGE	Init: CT&M Rec: EM	Init: ±5% or ±0.5 m/s (100 ft/min), but not less than aeroplane performance data requirements Rec: EM	Init: ±5% or ±0.5 m/s (100 ft/min), but not less than aeroplane performance data requirements Rec: EM
1.c.3	One engine inoperative en-route climb	Clean	Time	OGE		Init: ±10% Rec: EM	Init: ±10% Rec: EM
			Distance	OGE		Init: ±10% Rec: EM	Init: ±10% Rec: EM

1.c: Performance Climb		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
			Fuel used	OGE		Init: ±10% Rec: EM	Init: ±10% Rec: EM
1.c.4	One engine inoperative approach climb for aeroplanes with icing accountability if provided in the aeroplane performance data for this phase of flight	Approach	Airspeed	OGE		Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Rate of climb	OGE		Init: ±5% or ±0.5 m/s (100 ft/min), but not less than aeroplane performance data requirements Rec: EM	Init: ±5% or ±0.5 m/s (100 ft/min), but not less than aeroplane performance data requirements Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.c: Performance Climb		Test requirements
1.c.1	Normal climb all engines operating	1. Flight test data is preferred; however, aeroplane performance manual data is an acceptable alternative. 2. Record at nominal climb speed and mid initial climb altitude. 3. FSTD performance to be recorded over an interval of at least 300 m (1000 ft). 4. For fidelity levels G: This test may be a snapshot test.
1.c.2	One engine inoperative second segment climb	1. Flight test data is preferred; however, aeroplane performance manual data is an acceptable alternative. 2. Record at nominal climb speed. 3. FSTD performance to be recorded over an interval of at least 300 m (1000 ft). 4. Test at WAT (weight, altitude, or temperature) limiting condition. 5. For fidelity levels G: This test may be a snapshot test.

1.c: Performance Climb		Test requirements
1.c.3	One engine inoperative en-route climb	1. Flight test data or aeroplane performance manual data may be used. 2. Test for at least a 1550 m (5000 ft) segment.
1.c.4	One engine inoperative approach climb for aeroplanes with icing accountability if provided in the aeroplane performance data for this phase of flight	1. Flight test data or aeroplane performance manual data may be used. 2. FSTD performance to be recorded over an interval of at least 300 m (1000 ft). 3. Test near maximum certified landing weight as may be applicable to an approach in icing conditions. 4. Aeroplane shall be configured with all anti-ice and de-ice systems operating normally, gear up and go-around flap. 5. All icing accountability considerations, in accordance with the aeroplane performance data for an approach in icing conditions, shall be applied.

CS FSTD.QTG.A.115 Performance cruise and descent - Aeroplane

This CS provides standards of the objective tests for aeroplane cruise and descent performance.

1.d: Performance Cruise and Descent		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.d.1	Level flight acceleration	Cruise	Time	OGE	Init: CT&M Rec: EM	Init: ±5% Rec: EM	Init: ±5% Rec: EM
1.d.2	Level flight deceleration	Cruise	Time	OGE	Init: CT&M Rec: EM	Init: ±5% Rec: EM	Init: ±5% Rec: EM
1.d.3	Cruise performance	Cruise	Critical engine parameter	OGE		Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Fuel flow	OGE		Init: ±5% Rec: EM	Init: ±5% Rec: EM
1.d.4	Idle descent	Clean	Airspeed	OGE	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Rate of descent	OGE	Init: CT&M Rec: EM	Init: ±5% or ±1.0 m/s (200 ft/min) Rec: EM	Init: ±5% or ±1.0 m/s (200 ft/min) Rec: EM
1.d.5	Emergency descent	As per aeroplane performance data	Airspeed	OGE		Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Rate of descent	OGE		Init: ±5% or ±1.5 m/s (300 ft/min) Rec: EM	Init: ±5% or ±1.5 m/s (300 ft/min) Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.d: Performance Cruise and Descent		**Test requirements**
1.d.1	Level flight acceleration	1. Time required to increase airspeed a minimum of 50 kts, using maximum continuous thrust rating or equivalent. 2. For aeroplanes with a small operating speed range, speed change may be reduced to 80% of operational speed range.
1.d.2	Level flight deceleration	1. Time required to decrease speed a minimum of 50 kts, using idle power. 2. For aeroplanes with a small operating speed range, speed change may be reduced to 80% of operational speed range.
1.d.3	Cruise performance	1. The test may be a single snapshot showing instantaneous fuel flow, or a minimum of two consecutive snapshots with a spread of at least 3 minutes in steady flight. 2. In case of propeller-driven aircraft, the 'critical engine parameter' tolerance applies both to the engine parameter and propeller RPM.
1.d.4	Idle descent	1. Idle power stabilised descent at normal descent speed at mid altitude. 2. FSTD performance to be recorded over an interval of at least 300 m (1000 ft).
1.d.5	Emergency descent	1. Stabilised descent to be conducted with speed brakes extended if applicable, at mid altitude and near M_{MO} / V_{MO} or according to emergency descent procedure. 2. Flight simulator performance to be recorded over an interval of at least 900 m (3000 ft).

CS FSTD.QTG.A.120 Performance stopping - Aeroplane

This CS provides standards of the objective tests for aeroplane stopping performance.

1.e: Performance Stopping		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.e.1	Deceleration time and distance, manual wheel brakes, dry runway, no reverse thrust	Landing	Time	GND	Init: CT&M Rec: EM	Init: ±5% or ±1.5 s time Rec: EM	Init: ±5% or ±1.5 s time Rec: EM
			Distance	GND	Init: CT&M Rec: EM	Init: For distances up to 1220 m (4000 ft) ±61 m (200 ft) or ±10%, whichever is the smaller For distances greater than 1220 m (4000 ft) ±5% distance Rec: EM	Init: For distances up to 1220 m (4000 ft) ±61 m (200 ft) or ±10%, whichever is the smaller For distances greater than 1220 m (4000 ft) ±5% distance Rec: EM
1.e.2	Deceleration time and distance, reverse thrust, no wheel brakes, dry runway	Landing	Time	GND		Init: ±5% or ±1.5 s time Rec: EM	Init: ±5% or ±1.5 s time Rec: EM
			Distance	GND		Init: smaller of ±10% or ±61 m (200 ft) Rec: EM	Init: smaller of ±10% or ±61 m (200 ft) Rec: EM

<table>
<tr><th colspan="2" rowspan="2">1.e: Performance Stopping</th><th rowspan="2">Test Conditions</th><th rowspan="2">Tolerance Parameter</th><th rowspan="2">Primary Feature(s) Validated</th><th colspan="3">Tolerances</th></tr>
<tr><th>G</th><th>R</th><th>S</th></tr>
<tr><td>1.e.3</td><td>Stopping distance, wheel brakes, wet runway</td><td>Landing</td><td>Distance</td><td>GND</td><td></td><td></td><td>Init: ±10% or ±61 m (200 ft)
Rec: EM</td></tr>
<tr><td>1.e.4</td><td>Stopping distance, wheel brakes, icy runway</td><td>Landing</td><td>Distance</td><td>GND</td><td></td><td></td><td>Init: ±10% or ±61 m (200 ft)
Rec: EM</td></tr>
</table>

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

<table>
<tr><th colspan="2">1.e: Performance Stopping</th><th>Test requirements</th></tr>
<tr><td>1.e.1</td><td>Deceleration time and distance, manual wheel brakes, dry runway, no reverse thrust</td><td>1. Time and distance shall be recorded for at least 80% of the total time from touchdown to a full stop.
2. Position of ground spoilers and brake system pressure shall be plotted (if applicable).
3. Tests required for medium and near maximum certified landing mass.
4. Engineering validation data may be used for the medium mass condition.</td></tr>
<tr><td>1.e.2</td><td>Deceleration time and distance, reverse thrust, no wheel brakes, dry runway</td><td>1. Time and distance shall be recorded for at least 80% of the total time from initiation of reverse thrust to full thrust reverser minimum operating speed.
2. Position of ground spoilers shall be plotted (if applicable).
3. Tests required for medium and near maximum certified landing mass.
4. Engineering validation data may be used for the medium mass condition.</td></tr>
<tr><td>1.e.3</td><td>Stopping distance, wheel brakes, wet runway</td><td>1. Either flight test or manufacturers performance manual validation data shall be used where available.
2. Engineering validation data, based on dry runway flight test stopping distance and the effects of contaminated runway braking coefficients, are an acceptable alternative.</td></tr>
<tr><td>1.e.4</td><td>Stopping distance, wheel brakes, icy runway</td><td>1. Either flight test or manufacturer’s performance manual validation data shall be used where available.
2. Engineering validation data, based on dry runway flight test stopping distance and the effects of contaminated runway braking coefficients, are an acceptable alternative.</td></tr>
</table>

CS FSTD.QTG.A.125 Performance engines - Aeroplane

This CS provides standards of the objective tests for aeroplane engine performance.

1.f: Performance Engines		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.f.1	Acceleration	Either approach or landing	T_i and T_t	GND, IGE, OGE	Init: CT&M Rec: EM	Init: ±10% T_i or ±0.25 s and ±10% T_t or ±0.25 s Rec: EM	Init: ±10% T_i or ±0.25 s and ±10% T_t or ±0.25 s Rec: EM
1.f.2	Deceleration	Ground	T_i and T_t	GND, IGE, OGE	Init: CT&M Rec: EM	Init: ±10% T_i or ±0.25 s and ±10% T_t or ±0.25 s Rec: EM	Init: ±10% T_i or ±0.25 s and ±10% T_t or ±0.25 s Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.f: Performance Engines		Test requirements
1.f.1	Acceleration	1. T_i = Total time from initial throttle movement until a critical engine parameter reaches 10% of its total response above idle power. 2. T_t = Total time from initial throttle movement until a critical engine parameter reaches 90% of its total response above idle power. 3. Total response is the incremental change in the critical engine parameter from idle power to go-around power. 4. Refer to GM1 FSTD.QTG.A.125.
1.f.2	Deceleration	1. T_i = Total time from initial throttle movement until a critical engine parameter reaches 10% of its total response

1.f: Performance Engines		Test requirements
		below maximum take-off power. 2. T_t = Total time from initial throttle movement until a critical engine parameter reaches 90% of its total response below maximum take-off power. 3. Total response is the incremental change in the critical engine parameter from maximum take-off power to idle power. 4. Refer to GM1 FSTD.QTG.A.125.

GM1 FSTD.QTG.A.125 Engine performance assessment - Aeroplane

This GM provides guidance for the assessment of engine performance parameters.

Tests are required to show the response of the critical engine parameter to a rapid throttle movement for an engine acceleration and an engine deceleration. The procedure for evaluating the response is illustrated in figures 1 and 2.

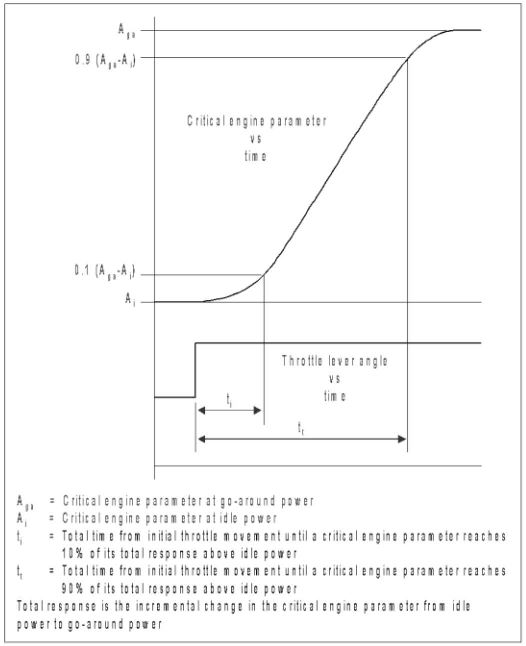

Figure 1. Engine acceleration

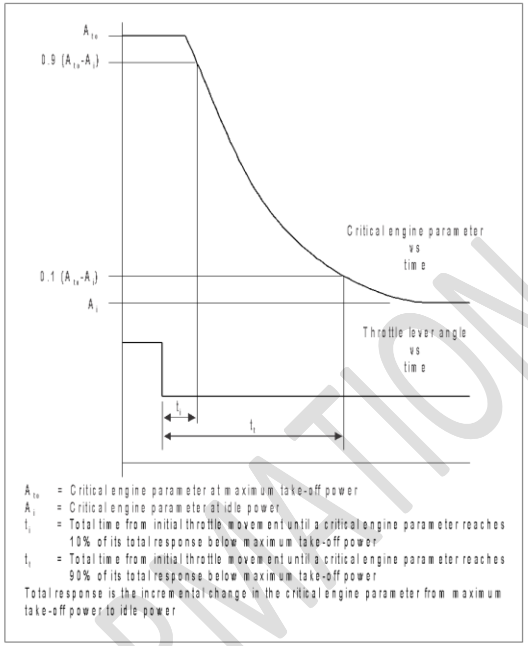

Figure 2. Engine deceleration

CS FSTD.QTG.A.200 Static control checks - Aeroplane

This CS provides standards of the objective tests for aeroplane static control checks.

2.a: Handling Qualities Static Control Checks		**Test Conditions**	**Tolerance Parameter**	**Primary Feature(s) Validated**	**Tolerances**		
					G	**R**	**S**
2.a.1	Pitch controller position versus force and surface position calibration	Ground	Breakout force	CLH		Init: CT&M Rec: ±0.9 daN (2 lb)	Init: ±0.9 daN (2 lb) Rec: same as Init
			Force	CLH		Init: CT&M Rec: ±2.2 daN (5 lb), or ±10%	Init: ±2.2 daN (5 lb), or ±10% Rec: same as Init
			Elevator angle	CLO		Init: CT&M Rec: EM	Init: ±2° Rec: EM
	Pitch controller position versus force	Approach	Breakout force	CLH	Init: CT&M Rec: ±0.9 daN (2 lb)		
			Force	CLH	Init: CT&M Rec: ±2.2 daN (5 lb), or ±10%		
2.a.2	Roll controller position versus force and surface position calibration	Ground	Breakout force	CLH		Init: CT&M Rec: ±0.9 daN (2 lb)	Init: ±0.9 daN (2 lb) Rec: same as Init
			Force	CLH		Init: CT&M Rec:±1.3 daN (3 lb), or ±10%	Init: ±1.3 daN (3 lb), or ±10% Rec: same as Init
			Aileron angle	CLO		Init: CT&M Rec: EM	Init: ±2° Rec: EM

2.a: Handling Qualities Static Control Checks		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
			Spoiler angle	CLO		Init: CT&M Rec: EM	Init: ±3° Rec: EM
	Roll controller position versus force	Approach	Breakout force	CLH	Init: CT&M Rec: ±0.9 daN (2 lb)		
			Force	CLH	Init: CT&M Rec:±1.3 daN (3 lb), or ±10%		
2.a.3	Rudder pedal position versus force and surface position calibration	Ground	Breakout force	CLH		Init: CT&M Rec: ±0.9 daN (2 lb)	Init: ±2.2 daN (5 lb) Rec: same as Init
			Force	CLH		Init: CT&M Rec: ±2.2 daN (5 lb), or ±10%	Init: ±2.2 daN (5 lb) or ±10% Rec: same as Init
			Rudder angle	CLO		Init: CT&M Rec: EM	Init: ±2° Rec: EM
	Rudder pedal position versus force	Approach	Breakout force	CLH	Init: CT&M Rec: ±0.9 daN (2 lb)		
			Force	CLH	Init: CT&M Rec: ±2.2 daN (5 lb), or ±10%		
2.a.4	Nosewheel steering controller force and position calibration	Ground	Breakout force	CLH		Init: CT&M Rec: ±0.9 daN (2 lb)	Init: ±0.9 daN (2 lb) Rec: same as Init
			Force	CLH		Init: CT&M Rec: ±1.3 daN (3 lb), or ±10%	Init: ±1.3 daN (3 lb), or ±10% Rec: same as Init

2.a: Handling Qualities Static Control Checks		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Nosewheel angle	CLO		Init: CT&M Rec: EM	Init: ±2° Rec: EM
2.a.5	Rudder pedal steering calibration	Ground	Nosewheel angle	CLO		Init: CT&M Rec: EM	Init: ±2° Rec: EM
2.a.6	Pitch trim versus surface position calibration	Ground	Trim angle	CLH	Init: CT&M Rec: ±1°	Init: CT&M Rec: ±1°	Init: ±0.5° Rec: same as Init
2.a.7	Pitch trim rate	Ground and approach	Trim rate	CLO	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% or ±0.1°/s Rec: EM
2.a.8	Alignment of flight deck throttle lever versus selected engine parameter	Ground	When matching engine parameters:				
			TLA	CLH	Init: CT&M Rec: ±5%	Init: CT&M Rec: ±5%	Init: ±5° or ±5% of travel Rec: same as Init
			When matching detents/lever positions:				
			Critical engine parameter	GND, IGE, OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3% Rec: EM
2.a.9	Brake pedal position versus force and brake system pressure calibration	Ground	Force	CLH		Init: CT&M Rec: ±2.2 daN (5 lb) or ±10%	Init: ±2.2 daN (5 lb) or ±10% Rec: same as Init
			Brake system pressure	CLO		Init: CT&M Rec: ±1.0 MPa (150 psi) or ±10%	Init: ±1.0 MPa (150 psi) or ±10% Rec: EM

2.a: Handling Qualities Static Control Checks		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.a.10	Stick pusher system force calibration (if applicable)	Either ground or flight	Stick/column transient force	CLH			Init: ±2.2 daN (5 lb) or ±10% Rec: same as Init

(a) Requirements for all the aeroplane static control checks:

2.a: Handling Qualities Static Control Checks	Test requirements
All static control checks	1. Plots of pitch, roll and yaw controller position versus force shall be measured at the control. a. An alternative method in lieu of external test fixtures at the flight controls is to have recording and measuring instrumentation built into the FSTD. The force and position data from this instrumentation shall be directly recorded and matched to the aeroplane data. b. Provided the instrumentation was verified by using external measuring equipment while conducting the static control checks, or equivalent means, and that evidence of the satisfactory comparison is included in the QTG, the instrumentation could be used for both initial and recurrent testing for the measurement of all required control checks. c. Verification of the instrumentation by using external measuring equipment shall be repeated if major modifications or repairs are made to the control loading system. Such a permanent installation could be used without any time being lost for the installation of external devices. 2. Static flight control checks shall be accomplished at the same feel or impact pressures as the validation data where applicable. 3. Pilot control positions shall be cross-plotted against control force and surface positions (e.g. elevator, nosewheel angle) or system parameters (e.g. brake pressure). 4. Static control checks from the second set of pilot controls are only required if both sets of controls are not mechanically interconnected on the FSTD. A rationale is required from the validation data provider if a single set of data is applicable to both sets of controls. If the controls are mechanically interconnected in the FSTD, a single set of checks are sufficient. 5. The static control checks must be conducted manually if the FSTD control positions are not back driven by the control

2.a: Handling Qualities Static Control Checks	Test requirements
	loading. 6. For irreversible flight control systems, if forces are generated solely by use of aircraft hardware in the FSTD, then testing of position versus force is not applicable.

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.a: Handling Qualities Static Control Checks		Test requirements
2.a.1	Pitch controller position versus force and surface position calibration	1. Uninterrupted control sweep to stops over approximately 100 s. 2. Test results shall be validated from in-flight data from tests such as longitudinal static stability, stalls, etc.
	Pitch controller position versus force	1. The test shall validate aerodynamic effects on controls. 2. For aeroplanes with reversible flight controls, the test will need to be run at a suitable airspeed condition.
2.a.2	Roll controller position versus force and surface position calibration	1. Uninterrupted control sweep to stops over approximately 100 s. 2. Test results shall be validated with in-flight data from tests such as engine out trims, steady state sideslips, etc.
	Roll controller position versus force	1. The test shall validate aerodynamic effects on controls. 2. For aeroplanes with reversible flight controls, the test will need to be run at a suitable airspeed condition.
2.a.3	Rudder pedal position versus force and surface position calibration	1. Uninterrupted control sweep to stops over approximately 100 s. 2. Test results shall be validated with in-flight data from tests such as engine out trims, steady state sideslips, etc.

2.a: Handling Qualities Static Control Checks		Test requirements
	Rudder pedal position versus force	1. The test shall validate aerodynamic effects on controls. 2. For aeroplanes with reversible flight controls, the test will need to be run at a suitable airspeed condition.
2.a.4	Nosewheel steering controller force and position calibration	1. Uninterrupted control sweep to stops.
2.a.5	Rudder pedal steering calibration	1. Uninterrupted control sweep to stops.
2.a.6	Pitch trim versus surface position calibration	1. The purpose of this test is to compare the FSTD surface position indicator and the FSTD flight controls model computed value against the validation data (e.g. design data or equivalent).
2.a.7	Pitch trim rate	1. Trim rate to be checked at pilot primary induced trim rate and autopilot or pilot primary trim rate in flight at go-around flight conditions. 2. Test applicable to simulated aeroplanes with electric trim systems.
2.a.8	Alignment of flight deck throttle lever versus selected engine parameter	1. Simultaneous recording for all engines. 2. The test procedure shall be either to carefully match the lever positions and check the resulting engine parameters, or match the engine parameters and check the resulting lever positions. 3. For aeroplanes with throttle/lever detents, all detents to be presented and at least one position between detents/endpoints (where practical). For aeroplanes without detents, end points and at least three other positions are to be presented. 4. Validation data from a test aeroplane or engineering test bench is acceptable, provided that the same engine controller (both hardware and software) is used. 5. In case of propeller-driven aircraft, the ‘critical engine parameter’ tolerance applies both to the engine parameter and propeller RPM. 6. In the case of propeller-driven aeroplanes, if an additional lever, usually referred to as the propeller lever, is present, it shall also be checked to be within the same tolerances as the TLA. 7. This test may be a series of snapshot tests.

2.a: Handling Qualities Static Control Checks		Test requirements
2.a.9	Brake pedal position versus force and brake system pressure calibration	1. Both left and right pedals from the same pilot seat shall be validated.
2.a.10	Stick pusher system force calibration	1. This test is required only for FSTDs that are to be qualified to conduct full-stall training tasks. 2. This test is intended to validate the stick/column transient force resulting from a stick pusher system activation. 3. 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 characteristic of an in-flight condition. 4. Aeroplane manufacturer design data may be utilised as validation data, if acceptable to the competent authority. 5. The test requirements may be met through column force validation in conjunction with the stall characteristics test (CS FSTD.QTG.A.210, test 2.c.8.a).

CS FSTD.QTG.A.205 Dynamic control checks - Aeroplane

This CS provides standards of the objective tests for aeroplane dynamic control checks.

2.b: Handling Qualities Dynamic Control Checks		**Test Conditions**	**Tolerance Parameter**	**Primary Feature(s) Validated**	**Tolerances**		
					G	**R**	**S**
2.b.1	Control dynamics pitch - dynamic releases	Take-off, cruise, and landing	For underdamped systems:				
			P_0: time from 90% of initial displacement (A_d) to first zero crossing	CLH			Init: ±10% of P_0 or ±0.05 s Rec: same as Init
			P_1: period of the 1st oscillation	CLH			Init: ±20% of P_1 or ±0.05 s Rec: same as Init
			P_2: period of the 2nd oscillation	CLH			Init: ±30% of P_2 or ±0.05 s Rec: same as Init
			P_n: period of the nth oscillation	CLH			Init: ±10(n+1)% of P_n or ±0.05 s Rec: same as Init
			A_n: Amplitude of the nth significant overshoot (outside the residual band)	CLH			Init: ±10% of A_{max}, where A_{max} is the largest amplitude or ±0.5% of the total control travel (stop to stop)

2.b: Handling Qualities Dynamic Control Checks		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
							Rec: same as Init
			Number of significant overshoots	CLH			Init: ±1 significant overshoots (minimum of 1 significant overshoot) Rec: same as Init
			For overdamped and critically damped systems only				
			P_0: time from 90% of initial displacement (A_d) to 10% of A_d	CLH			Init: ±10% of P_0 or ±0.05 s Rec: same as Init
	Control dynamics pitch - sweeps	Ground, and flight Slow sweep, and Fast sweep	Force	CLH		Init: ±0.9 daN (2 lb) or ±10% Rec: same as Init	
2.b.2	Control dynamics roll - dynamic releases	Take-off, cruise, and landing	Same as 2.b.1	CLH			Same as 2.b.1
	Control dynamics roll - sweeps	Ground, and flight Slow sweep, and Fast sweep	Same as 2.b.1	CLH		Same as 2.b.1	

2.b: Handling Qualities Dynamic Control Checks		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.b.3	Control dynamics yaw - dynamic releases	Take-off, cruise, and landing	Same as 2.b.1	CLH			Same as 2.b.1
	Control dynamics yaw - sweeps	Ground, and flight Slow sweep, and Fast sweep	Same as 2.b.1	CLH		Same as 2.b.1	
2.b.4	Small control inputs - pitch	Either approach or landing	Body pitch rate	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±0.15°/s Rec: EM
		CCA: Test in normal <u>and</u> non-normal control state	Peak body pitch rate applied throughout the time history	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±20% Rec: EM
2.b.5	Small control inputs - roll	Either approach or landing	Body roll rate	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±0.15°/s Rec: EM
		CCA: Test in normal <u>and</u> non-normal control state	Peak body roll rate applied throughout the time history	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±20% Rec: EM
2.b.6	Small control inputs - yaw	Either approach or landing	Body yaw rate	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±0.15°/s Rec: EM
		CCA: Test in normal <u>and</u> non-normal control state	Peak body yaw rate applied throughout the time history	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±20% Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.b: Handling Qualities Dynamic Control Checks		Test requirements
2.b.1	Control dynamics pitch - dynamic releases	1. Test not applicable for FSTDs where the control forces are completely generated within the aeroplane controller unit installed in the FSTD. 2. Data shall 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). 3. Tolerances apply against the absolute values of each period (considered independently). 4. n = The sequential period of a full oscillation. 5. Refer to GM1 FSTD.QTG.A.205. 6. Static and dynamic flight control tests shall be accomplished at the same feel or impact pressures as the validation data where applicable
	Control dynamics pitch - sweeps	1. The method applies to feature CLH at fidelity level R. Instead of free response measurements, the system is validated by measurements of control force and rate of movement. 2. The control shall be forced to its maximum extreme position (for tests conducted on the ground) or to the maximum safe displacement (for tests conducted in-flight) for the following distinct rates. The intent is to validate the flight control force damping characteristics a. Static test: refer to CS FSTD.QTG.A.200, test 2.a.1 Pitch controller position versus force and surface position calibration. b. Slow dynamic sweep: achieve a full sweep in approximately 10 s, or the longest period which can be achieved safely for tests conducted in-flight. c. Fast dynamic sweep: achieve a full sweep in approximately 4 s. 3. Dynamic sweeps may be limited to forces not exceeding 44.5 daN (100 lb).
2.b.2	Control dynamics roll - dynamic releases	1. Test not applicable for FSTDs where the control forces are completely generated within the aeroplane controller unit installed in the FSTD. 2. Data shall 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). 3. Tolerances apply against the absolute values of each period (considered independently).

2.b: Handling Qualities Dynamic Control Checks		Test requirements
		4. n = The sequential period of a full oscillation. 5. Refer to GM1 FSTD.QTG.A.205. 6. Static and dynamic flight control tests shall be accomplished at the same feel or impact pressures as the validation data where applicable
	Control dynamics roll - sweeps	1. The method applies to feature CLH at fidelity level R. Instead of free response measurements, the system is validated by measurements of control force and rate of movement. 2. The control shall be forced to its maximum extreme position (for tests conducted on the ground) or to the maximum safe displacement (for tests conducted in-flight) for the following distinct rates. The intent is to validate the flight control force damping characteristics a. Static test: refer to CS FSTD.QTG.A.200, test 2.a.2 Roll controller position versus force and surface position calibration. b. Slow dynamic sweep: achieve a full sweep in approximately 10 s, or the longest period which can be achieved safely for tests conducted in-flight. c. Fast dynamic sweep: achieve a full sweep in approximately 4 s. 3. Dynamic sweeps may be limited to forces not exceeding 44.5 daN (100 lb).
2.b.3	Control dynamics yaw - dynamic releases	1. Test not applicable for FSTDs where the control forces are completely generated within the aeroplane controller unit installed in the FSTD. 2. Data shall be for normal displacement (approximately 25% to 50% of full throw). 3. Tolerances apply against the absolute values of each period (considered independently). 4. n = The sequential period of a full oscillation. 5. Refer to GM1 FSTD.QTG.A.205. 6. Static and dynamic flight control tests shall be accomplished at the same feel or impact pressures as the validation data where applicable.
	Control dynamics yaw - sweeps	1. The method applies to feature CLH at fidelity level R. Instead of free response measurements, the system is validated by measurements of control force and rate of movement.

2.b: Handling Qualities Dynamic Control Checks		Test requirements
		2. The control shall be forced to its maximum extreme position (for tests conducted on the ground) or to the maximum safe displacement (for tests conducted in-flight) for the following distinct rates. The intent is to validate the flight control force damping characteristics a. Static test: refer to CS FSTD.QTG.A.200, test 2.a.3 Yaw controller position versus force and surface position calibration. b. Slow dynamic sweep: achieve a full sweep in approximately 10 s, or the longest period which can be achieved safely for tests conducted in-flight. c. Fast dynamic sweep: achieve a full sweep in approximately 4 s. 3. Dynamic sweeps may be limited to forces not exceeding 44.5 daN (100 lb).
2.b.4	Small control inputs - pitch	1. Control inputs shall be typical of minor corrections made while established on an ILS approach (approximately 0.5°/s to 2°/s pitch rate). 2. Test in both directions. 3. Show time history data from 5 s before until at least 5 s after initiation of control input. 4. If a single test is used to demonstrate both directions, there shall be a minimum of 5 s before control reversal to the opposite direction. 5. CCA: Test in normal <u>and</u> non-normal control state.
2.b.5	Small control inputs - roll	1. Control inputs shall be typical of minor corrections made while established on an ILS approach (approximately 0.5°/s to 2°/s roll rate). 2. Test in one direction. 3. For aeroplanes that exhibit non-symmetrical behaviour, test in both directions. 4. Show time history data from 5 s before until at least 5 s after initiation of control input. 5. If a single test is used to demonstrate both directions, there shall be a minimum of 5 s before control reversal to the opposite direction. 6. CCA: Test in normal <u>and</u> non-normal control state.
2.b.6	Small control inputs - yaw	1. Control inputs shall be typical of minor corrections made while established on an ILS approach (approximately 0.5°/s to 2°/s yaw rate).

2.b: Handling Qualities Dynamic Control Checks		Test requirements
		2. Test in both directions. 3. Show time history data from 5 s before until at least 5 s after initiation of control input. 4. If a single test is used to demonstrate both directions, there shall be a minimum of 5 s before control reversal to the opposite direction. 5. CCA: Test in normal <u>and</u> non-normal control state.

GM1 FSTD.QTG.A.205 Dynamic control checks - Aeroplane

This GM provides guidance for the assessment of flight controls dynamic tests parameters.

(a) General

The characteristics of an aircraft flight control system have a major effect on handling qualities. A significant consideration in pilot acceptability of an aircraft is the ‘feel’ provided through the flight controls. Considerable effort is expended on aircraft feel system design so that pilots will be comfortable and will consider the aircraft desirable to fly. In order for an FSTD to be representative, it too should present the pilot with the proper feel – that of the aircraft being simulated. Compliance with this requirement should be determined by comparing a recording of the control feel dynamics of the FSTD to actual aircraft measurements in the take-off, cruise and landing configurations.

(1) Recordings such as free response to a pulse or step function are classically used to estimate the dynamic properties of electromechanical systems. In any case, the dynamic properties can only be estimated since the true inputs and responses are also only estimated. Therefore, it is imperative that the best possible data be collected since close matching of the FSTD control loading system to the aircraft systems is essential. The required dynamic control checks are indicated in 2.b.1 to 2.b.3 of the table of FSTD validation tests versus feature fidelity levels in CS FSTD.QTG.A.205.

(2) For initial and upgrade evaluations, control dynamics characteristics should be measured at and recorded directly from the flight controls. This procedure is usually accomplished by measuring the free response of the controls using a step input or pulse input to excite the system. The procedure should be accomplished in the take-off, cruise and landing flight conditions and configurations.

(3) For aircraft with irreversible control systems, measurements may be obtained on the ground if proper pitot-static inputs (if applicable) are provided to represent airspeeds typical of those encountered in flight. Likewise, it may be shown that for some aircraft, take-off, cruise, and landing configurations have similar effects. Thus, one configuration may suffice. If either or both considerations apply, engineering validation

or aircraft manufacturer rationale should be submitted as justification for ground tests or for eliminating a configuration. For FSTDs requiring static and dynamic tests at the controls, special test fixtures should not be required during initial and upgrade evaluations if the MQTG shows both test fixture results and the results of an alternate approach, such as computer plots which were produced concurrently and show satisfactory agreement. Repeat of the alternate method during the initial evaluation would then satisfy this test requirement.

(b) Control dynamics evaluation

The dynamic properties of control systems are often stated in terms of frequency, damping, and a number of other classical measurements which can be found in various documents available on control systems. In order to establish a consistent means of validating test results for FSTD control loading, criteria are needed that clearly define the interpretation of the measurements and the tolerances to be applied. Criteria are needed for underdamped, critically damped, and overdamped systems. In the case of an underdamped system with very light damping, the system may be quantified in terms of frequency and damping. In critically damped or overdamped systems, the frequency and damping are not readily measured from a response time history. Therefore, some other measurement should be used.

Tests to verify that control feel dynamics represent the aircraft should show that the dynamic damping cycles (free response of the controls) match those of the aircraft within specified tolerances. The method of evaluating the response and the tolerance to be applied is described in the underdamped and critically damped cases. The response is as follows:

(1) Underdamped response

(i) Two measurements are required for the period, the time to first zero crossing (in case a rate limit is present) and the subsequent frequency of oscillation. It is necessary to measure cycles on an individual basis in case there are non-uniform periods in the response. Each period should be independently compared with the respective period of the aircraft control system and, consequently, should enjoy the full tolerance specified for that period.

(ii) The damping tolerance should be applied to overshoots on an individual basis. Care should be taken when applying the tolerance to small overshoots since the significance of such overshoots becomes questionable. Only those overshoots larger than 5% of the total initial displacement should be considered. The residual band, labelled $T(A_d)$ in figure 1 is ±5% of the initial displacement amplitude Ad from the steady state value of the oscillation. Only oscillations outside the residual band are considered significant. When comparing FSTD data to the aircraft data, the process should begin by overlaying or aligning the FSTD and aircraft steady state values and then comparing amplitudes of oscillation peaks, the time of the first zero crossing, and individual periods of oscillation. The FSTD should show the same number of significant overshoots when compared against the aircraft data. This procedure for evaluating the response is illustrated in figure 1.

(2) Critically damped and overdamped response

Due to the nature of critically damped and overdamped responses (no overshoots), the time to travel from 90% of the initial displacement to 10 % of the steady state (neutral point) value should be the same as the aircraft within ± 10% or ± 0.05 s. Figure 2 illustrates the procedure.

(3) Special considerations

Control systems that exhibit characteristics other than classical overdamped or underdamped responses should meet specified tolerances. In addition, special consideration should be given to ensure that significant trends are maintained.

(c) Tolerances

The following summarises the tolerances, T. See figures 1 and 2 for an illustration of the referenced measurements.

$T(P_0)$ ±10% of P_0 or ±0.05 s.

$T(P_1)$ ±20% of P_1 or ±0.05 s.

$T(P_2)$ ±30% of P_2 or ±0.05 s.

$T(P_n)$ ±10(n+1) % of P_n or ±0.05 s.

$T(A_n)$ ±1% of A_{max}, where A_{max} is the largest amplitude or ±0.5 % of the total control travel (stop to stop).

Where:

Residual band $T(A_d)$ = either ±5% of A_d, or ±0.5 % of the maximum control travel.

±1 significant overshoots (minimum of 1 significant overshoot).

Steady state position within residual band.

Note 1. Tolerances should not be applied on period or amplitude after the last significant overshoot.

Note 2. Oscillations within the residual band are not considered significant and are not subject to tolerances.

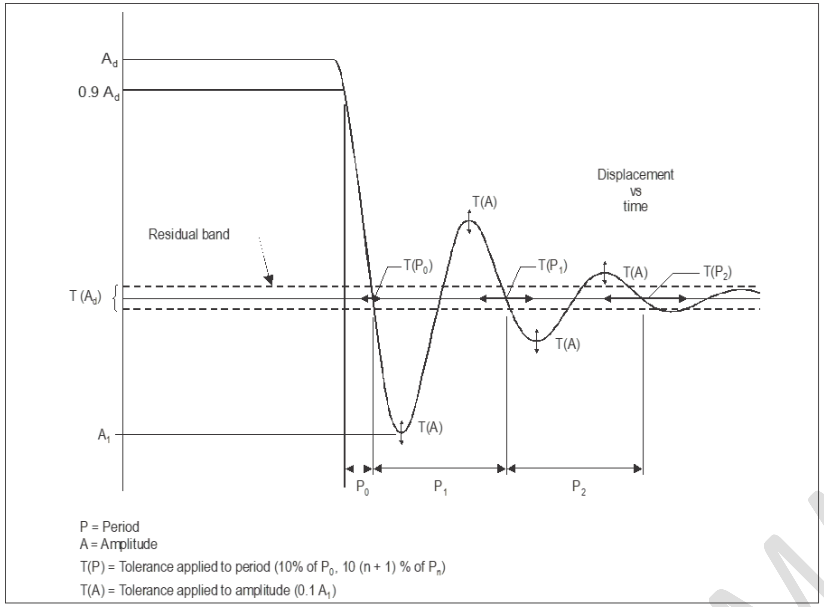

Figure 1. Underdamped step response

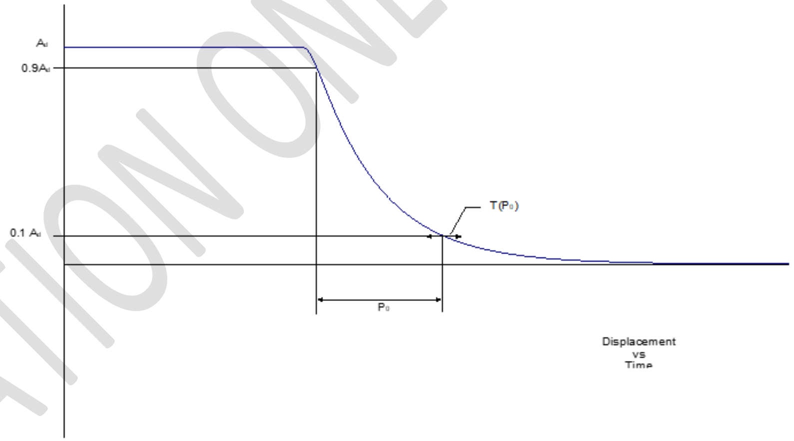

Figure 2. Critically damped step response

The following tolerance applies only to the overdamped and critically damped systems (see Figure 2 above for an illustration of the reference measurement):

$T(P_0)$ ±10% of P_0 or ±0.05 s.

(d) Alternate method for control dynamics evaluation

The method applies to aircraft with hydraulically powered flight controls and artificial feel systems or to FSTDs with feature CLH at fidelity level R. Instead of free response measurements, the system would be validated by measurements of control force and rate of movement.

These tests should be conducted under typical flight and ground conditions. For each axis of pitch, roll and yaw, the control should be forced to its maximum extreme position for the following distinct rates:

(1) Static test: slowly move the control such that approximately 100 s are required to achieve a full sweep. A full sweep is defined as the movement of the controller from neutral to the stop, usually aft or right stop, then to the opposite stop, then to the neutral position. Tolerances: see 2.a.1, 2.a.2, and 2.a3 of the table of FSTD validation tests versus feature fidelity levels in CS FSTD.QTG.A.200.

(2) Slow dynamic test: achieve a full sweep in approximately 10 s. Tolerance: ±0.9 daN (2 lb) or ±10% on dynamic increment above static test.

(3) Fast dynamic test: achieve a full sweep in approximately 4 s. Tolerance: ±0.9 daN (2 lb) or ±10% on dynamic increment above static test.

Note: Dynamic sweeps may be limited to forces not exceeding 44.5 daN (100 lb).

(e) Alternate reference line evaluation method for control dynamics evaluation

(1) Background

(i) When evaluating a flight control dynamic response, the periods, amplitudes and residual band are defined with respect to a reference line, which is the steady state value of the control. This selection is made since it is assumed that the steady state value is representative of the control’s rest position throughout the test. For standard irreversible control systems, this is very often a valid assumption. However, in the case of reversible control systems, for example, aerodynamic forces on the control surfaces influence the instantaneous rest position of the control. During the dynamic test, the control’s rest position will vary in response to the variance of the flight conditions. In such a case, the instantaneous rest position and steady state value at the end of the test are not equivalent. When the tolerances are applied to the entire dynamic response based on the steady state value, they may become incorrect and lead to problems evaluating the cases.

(ii) In such cases, an alternate reference line may be used, which attempts to better approximate the true rest position of the control throughout a step response. That reference line is obtained as described in Section (2) ‘Alternate reference line’ below.

(iii) The rest position is defined as the position where the control would eventually settle if no pilot forces were applied to it (left free). This position may or may not be affected by the aerodynamic conditions, the aircraft configuration and the acceleration it is subjected to. It will depend on the type of flight control system in the aircraft. Typically, reversible control systems will be affected while irreversible systems will not. The instantaneous rest position is defined as the theoretical rest position at a particular point in time and at the same conditions at that moment.

(2) Alternate reference line

(i) On the control position curve, identify median points, defined as points on the control position curve located equidistantly between two consecutive peaks, measured vertically (see figure 3). The last median point is the first point where the dynamic portion of the response has ended rather than the mid-point between the last peak and the end of the dynamic portion.

(ii) Join the median points to produce the 'line of medians'. Then, identify reference points, defined as the intersection of a vertical line passing through a position peak and the line of medians (see figure 4).

(iii) The first reference point is the last control position before the start of the excitation. When this part of the data is not available, project the first available reference point horizontally to time zero. The last reference point is simply the last median point.

(iv) Link all the reference points to obtain the alternate reference line (see figure 4), and append the final non-dynamic portion to it.

(3) Tolerances

The final alternate reference line (see figure 5) may be used to calculate the conventional tolerances described in 2.b.1, 2.b.2, and 2.b.3 of the table of FSTD validation tests versus feature fidelity levels in CS FSTD.QTG.A.205. Note that the residual band T(Ad) should be at a distance of ±5% percent of Ad or ±0.5% of the total control travel (stop to stop) from the alternate reference line. Its shape will therefore follow the alternate reference line.

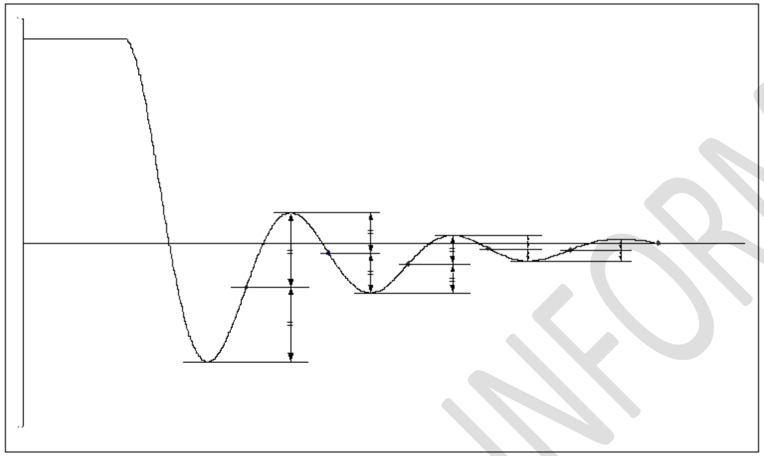

Figure 3. Locating median points

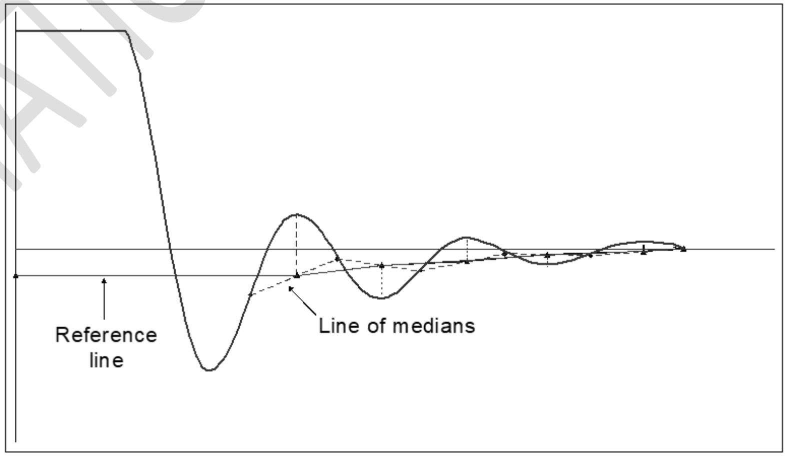

Figure 4. Producing the alternate reference line

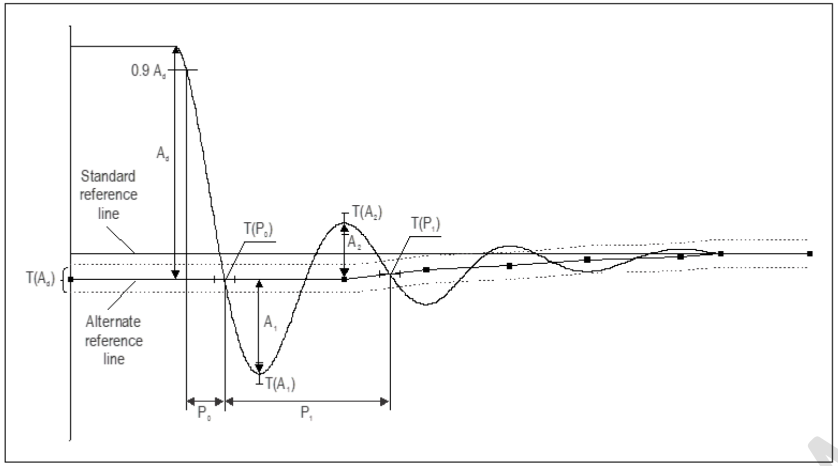

Figure 5. Tolerances applied using the alternate reference line

(f) The competent authority should consider alternative means such as the ones described above. Such alternatives should, however, be justified and appropriate to the application. For example, the method described here may not apply to all manufacturers' systems and certainly not to aircraft with reversible control systems. Hence, each case should be considered on its own merit on an ad hoc basis. Should the competent authority find that alternative methods do not result in satisfactory performance, then more conventionally accepted methods should be used.

CS FSTD.QTG.A.210 Handling qualities longitudinal - Aeroplane

This CS provides standards of the objective tests for aeroplane longitudinal handling qualities.

2.c: Handling Qualities Longitudinal		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.c.1	Power change dynamics	Approach CCA: Test in normal and non-normal control state. For feature OGE at fidelity levels G or R: Test in normal mode only	Airspeed	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Altitude	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±30 m (100 ft) Rec: EM
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° or ±20% Rec: EM
			Alternative method for aeroplanes with OGE feature at fidelity level G.				
			Pitch controller force	OGE	Init: CT&M Rec: EM		
2.c.2	Flap change dynamics	Take-off through initial flap retraction, and approach to landing CCA: Test in normal and non-normal control state For feature OGE at fidelity levels G or R: Test in normal	Airspeed	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Altitude	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±30 m (100 ft) Rec: EM
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° or ±20% Rec: EM
			Alternative method for aeroplanes with OGE feature at fidelity level G.				
			Pitch controller force	OGE	Init: CT&M Rec: EM		

2.c: Handling Qualities Longitudinal		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
		mode only					
2.c.3	Spoiler / speed brake change dynamics	Cruise CCA: Test in normal and non-normal control state For feature OGE at fidelity level G or R: Test in normal mode only	Airspeed	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Altitude	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±30 m (100 ft) Rec: EM
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° or ±20% Rec: EM
2.c.4	Gear change dynamics	Take-off (retraction), and approach (extension) CCA: Test in normal and non-normal control state For feature OGE at fidelity levels G or R: Test in normal mode only	Airspeed	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Altitude	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±30 m (100 ft) Rec: EM
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° or ±20% Rec: EM
			Alternative method for aeroplanes with OGE feature at fidelity level G.				
			Pitch controller force	OGE	Init: CT&M Rec: EM		
2.c.5	Longitudinal trim	Cruise, approach, and landing CCA: Test in normal or non-normal	Elevator angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1° Rec: EM
			Trim angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±0.5° Rec: EM

2.c: Handling Qualities Longitudinal		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
		control state, as applicable	Pitch angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1° Rec: EM
			Net thrust or equivalent.	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
2.c.6	Longitudinal manoeuvring stability (stick force/g)	Cruise, approach, and landing CCA: Test in normal <u>and</u> non-normal control state, as applicable For feature OGE at fidelity levels G or R: Test in normal mode only	Pitch controller force	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2.2 daN (5 lb) or ±10% Rec: EM
			Alternative tolerance for aeroplanes which do not exhibit stick-force-per-g characteristics.				
			Change of elevator angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1° or ±10% Rec: EM
2.c.7	Longitudinal static stability	Approach CCA: Test in normal <u>or</u> non-normal control state	Pitch controller force	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2.2 daN (5 lb) or ±10% Rec: EM
			Alternative tolerance for aeroplanes which do not exhibit speed stability characteristics.				
			Change of elevator angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1° or ±10% Rec: EM
2.c.8.a	Stall characteristics (Applicable only for those FSTDs that	2nd segment climb, high-altitude cruise, (near	Airspeed for stall warning and stall speeds	OGE			Init: ±3 kts Rec: EM

2.c: Handling Qualities Longitudinal		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
	are to be qualified for full stall training tasks.)	performance-limited condition), and either approach or landing Wings level, turning flight, and power on stall entry methods CCA: Aeroplanes with stall envelope protection systems: test in normal and non-normal control states	Airspeed for stall warning and stall speeds	OGE			Init: ±3 kts Rec: EM
			AoA for the buffet threshold of perception and for the initial buffet based upon the Nz component	VIB			Init: ±2° Rec: EM
			Primary flight control inputs	CLO			Init: CT&M Rec: EM
			Approach to stall:				
			Pitch angle	OGE			Init: ±2.0° Rec: EM
			AoA	OGE			Init: ±2.0° Rec: EM
			Bank angle	OGE			Init: ±2.0° Rec: EM
			Stall warning up to stall:				
			Pitch angle	OGE			Init: ±2.0° Rec: EM
			AoA	OGE			Init: ±2.0° Rec: EM

2.c: Handling Qualities Longitudinal		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Roll rate	OGE			Init: CT&M Rec: EM
			Yaw rate	OGE			Init: CT&M Rec: EM
			Stall break and recovery:				
			see para 4.f in table below				
			Additionally, for those simulators with reversible flight control systems or equipped with stick pusher systems:				
			Stick/column force (prior to the stall AoA)	OGE			Init: ±10% or ±2.2 daN (5 lb) Rec: EM
2.c.8.b	Approach-to-stall characteristics (Applicable only for those FSTDs that are not to be qualified for full stall training tasks.)	2nd segment climb, high-altitude cruise (near performance limited condition), and either approach or landing CCA: Test in normal <u>and</u> non-normal control state For feature OGE at	Airspeed for stall warning speeds	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ± 3 kts Rec: EM
			AoA initial buffet	VIB	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2.0° Rec: EM
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2.0° Rec: EM
			AoA	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2.0° Rec: EM
			Bank angle.	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2.0° Rec: EM

2.c: Handling Qualities Longitudinal		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
		fidelity levels G & R: Test in normal mode only	Control inputs	CLO	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: CT&M Rec: EM
			Additionally, for those aeroplanes with reversible flight control systems:				
			Stick/column force	OGE	-	Init: CT&M Rec: EM	Init: ±10% or ±2.2 daN (5 lb) Rec: EM
2.c.9	Phugoid dynamics	Cruise CCA: Test in non-normal control state	Period	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Time to one half or double amplitude, or damping ratio	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% time or ±0.02 of damping Rec: EM
2.c.10	Short-period dynamics	Cruise CCA: Test in normal and non-normal control state	Pitch angle or pitch rate	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° or ±2°/s Rec: EM
			Normal acceleration	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±0.1 g Rec: EM

(a) Requirements for all the aeroplane longitudinal tests:

2.c: Handling Qualities Longitudinal	Test requirements
All tests	1. Power setting may be that required for level flight unless otherwise specified.

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.c: Handling Qualities Longitudinal		Test requirements
2.c.1	Power change dynamics	1. Power change from thrust for approach or level flight to maximum continuous or go-around power. 2. 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. 3. CCA: Test in normal and non-normal control state. 4. For fidelity levels G and R: Test in normal mode only. 5. Alternative method test for aeroplanes with OGE feature at fidelity level G shall provide the force required to maintain constant altitude or vertical speed to complete the configuration change.
2.c.2	Flap change dynamics	1. Time history of uncontrolled free response for a time increment equal to at least 5 s before initiation of the reconfiguration change to completion of the reconfiguration change +15 s. 2. CCA: Test in normal and non-normal control state. 3. For fidelity level G and R: Test in normal mode only. 4. Alternative method test for aeroplanes with OGE feature at fidelity level G shall provide the force required to maintain constant altitude or vertical speed to complete the configuration change.
2.c.3	Spoiler / speed brake change dynamics	1. Time history of uncontrolled free response for a time increment equal to at least 5 s before initiation of the reconfiguration change to completion of the reconfiguration change +15 s. 2. Results required for both extension and retraction. 3. CCA: Test in normal and non-normal control state. 4. For fidelity level G and R: Test in normal mode only.
2.c.4	Gear change dynamics	1. Time history of uncontrolled free response for a time increment equal to at least 5 s before initiation of the configuration change to completion of the reconfiguration change +15 s. 2. CCA: Test in normal and non-normal control state. 3. For fidelity level G and R: Test in normal mode only. 4. Alternative method test for aeroplanes with OGE feature at fidelity level G shall provide the force required to maintain constant altitude or vertical speed to complete the configuration change
2.c.5	Longitudinal trim	1. Steady-state wings level trim with thrust for level flight. 2. This test may be a series of snapshot tests. 3. CCA: Test in normal or non-normal control state, as applicable. 4. For feature OGE at fidelity level G: Pitch controller position tolerance parameter instead of elevator and trim angle

2.c: Handling Qualities Longitudinal		Test requirements
		may be used
2.c.6	Longitudinal manoeuvring stability (stick force/g)	1. Continuous time history data or a series of snapshot tests may be used. 2. Test up to approximately 30° of roll angle for approach and landing configurations. 3. Test up to approximately 45° of roll angle for the cruise configuration. 4. Force tolerance not applicable if forces are generated solely by the use of aeroplane hardware in the FSTD. 5. For feature OGE at fidelity level S: CCA: Test in normal and non-normal control state. 6. For feature OGE at fidelity levels G and R: Test in normal mode only. 7. For feature OGE at fidelity levels G and R: Tests in cruise, approach or landing if appropriate. 8. For the alternative method, feature OGE at fidelity level G: Pitch controller position tolerance parameter instead of elevator angle may be used.
2.c.7	Longitudinal static stability	1. Data for at least two speeds above and two speeds below trim speed. The speed range shall be sufficient to demonstrate stick force versus speed characteristics. 2. This test may be a series of snapshot tests. 3. Force tolerance not applicable if forces are generated solely by the use of aeroplane hardware in the FSTD. 4. CCA: Test in normal or non-normal control state, as applicable. 5. For the alternative method, feature OGE at fidelity level G: Pitch controller position tolerance parameter instead of elevator angle may be used.
2.c.8.a	Stall characteristics (Applicable only for those FSTDs that are to be qualified for full stall training tasks.)	1. Applicable only for those FSTDs that are to be qualified for full-stall training tasks. 2. Flight Phase / Test Conditions: a. The test shall be performed from the approach to stall through to the full stall and recovery to normal flight. b. For safety of flight considerations, flight test validation data may be limited to the stall angle of attack. 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. c. The following stall entry methods shall be demonstrated: i. Stall entry at wings level (1g) ii. Stall entry in turning flight of at least 25° bank angle (accelerated stall) iii. Stall entry in a power-on condition (required only for propeller-driven aeroplanes) iv. Note: The entry methods shall be demonstrated at least once in the entirety of tests provided for the

2.c: Handling Qualities Longitudinal		Test requirements
		2.c.8.a requirement. It is not required to demonstrate each entry method in each flight phase. d. The cruise flight phase shall be conducted in a flaps-up (clean) configuration. e. The second-segment climb flight phase shall use a different flap setting from that for the approach or landing flight condition. f. Tests may be conducted at CoG and weights typically required for aeroplane certification stall testing. 3. CCA Aeroplanes: a. For aeroplanes with stall envelope protection systems, test in normal and non-normal control states. i. Normal control state: 1. It is expected that envelope protections will take effect, and it may not be possible to reach the aerodynamic stall condition for some aeroplanes. 2. The test is only required for an angle of attack range necessary to demonstrate the correct operation of the envelope protection system. 4. Objective test result: a. For feature VIB at fidelity level S: The test shall be run with the VIB feature active. b. The stall warning signal shall occur in the proper relation to buffet/stall. FSTDs of aeroplanes exhibiting a sudden pitch attitude change or 'g break' shall demonstrate this characteristic. FSTDs of aeroplanes exhibiting a roll-off or loss-of-roll control authority shall demonstrate this characteristic. c. The stall warning signal and initial buffet signal measured by the FSTD accelerometers, if applicable, shall be recorded. d. Buffet threshold of perception shall be based on 0.03g 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). The test shall demonstrate the correct trend in growth of buffet amplitude from initial buffet to stall speed for normal and lateral acceleration. e. 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 shall 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 shall be informed of the limitations. f. Numerical tolerances are not applicable past the stall angle of attack but shall demonstrate correct trend through recovery. (Refer to CS FSTD.QB.107.3.STALL for requirements regarding the aerodynamic model SOJ).

2.c: Handling Qualities Longitudinal		Test requirements
		g. Where approved engineering simulation validation is used, the reduced engineering tolerances (as defined in CS FSTD.QTG.025 paragraph (a)(2)) do not apply. 5. These tests may be used to satisfy the Angle of Attack test Flight manoeuvre and envelope protection functions test requirement (CS FSTD.QTG.A.235, 2.h.6).
2.c.8.b	Approach-to-stall characteristics (Applicable only for those FSTDs that are not to be qualified for full stall training tasks.)	1. Applicable for FSTDs not qualified to conduct full-stall training tasks. 2. For feature OGE at fidelity levels G and R: Test in normal mode only. 3. Flight Phase / Test Conditions (feature OGE at fidelity level S only): a. The following stall entry methods shall be demonstrated: i. Stall entry at wings level (1g) ii. Stall entry in turning flight of at least 25° bank angle (accelerated stall) iii. Stall entry in a power-on condition (required only for propeller-driven aeroplanes) iv. Note: The entry methods shall be demonstrated at least once in the entirety of tests provided for the 2.c.8.b requirement. It is not required to demonstrate each entry method in each flight phase. b. The cruise flight phase shall be conducted in a flaps-up (clean) configuration. c. The second-segment climb flight phase shall use a different flap setting from that for the approach or landing flight condition. d. Tests may be conducted at CoG and weights typically required for aeroplane certification stall testing. 4. CCA Aeroplanes: a. For aeroplanes with stall envelope protection systems, test in normal <u>and</u> non-normal control states. i. Normal control state: The test is only required for an angle of attack range necessary to demonstrate the correct operation of the envelope protection system. 5. These tests may be used to satisfy the Angle of Attack test Flight manoeuvre and envelope protection functions test requirement (CS FSTD.QTG.A.235, 2.h.6).
2.c.9	Phugoid dynamics	1. The test shall include three full cycles or those necessary to determine time to one half or double amplitude, whichever is less. 2. CCA: Test in non-normal control state.
2.c.10	Short-period dynamics	1. CCA: Test in normal <u>and</u> non-normal control state.

CS FSTD.QTG.A.215 Handling qualities lateral directional - Aeroplane

This CS provides standards of the objective tests for aeroplane lateral directional handling qualities.

2.d: Handling Qualities Lateral Directional		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.d.1	Minimum control speed, air (V_{MCA} or V_{MCL})	Either take-off or landing (whichever is most critical in the aeroplane) CCA: Test in normal or non-normal control state	Airspeed	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
2.d.2	Roll response (rate)	Cruise, and either approach or landing	Roll rate	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% or ±2°/s Rec: EM
			For aeroplanes with reversible flight control systems:				
			Roll controller force	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.3 daN (3 lb) or ±10% Rec: EM
2.d.3	Step input of flight deck roll controller (or roll overshoot)	Either approach or landing CCA: Test in normal and non-normal control state For feature OGE at fidelity level G: Test in normal mode	Bank angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% or ±2° Rec: EM

2.d: Handling Qualities Lateral Directional		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
		only					
2.d.4	Spiral stability	Cruise, and either approach or landing CCA: Test in non-normal control state	Bank angle in 20 s	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: Correct trend and ±2° or ± 10% Rec: EM
			If alternate test is used:				
			Aileron angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2° Rec: EM
2.d.5	Engine inoperative trim	2nd segment climb, and either approach or landing	Rudder angle or tab angle or equivalent rudder pedal	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1° Rec: EM
			Sideslip angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2° Rec: EM
2.d.6	Rudder response	Either approach or landing For feature OGE at fidelity level S and R:Test with stability augmentation ON and OFF. For feature OGE at fidelity level G: Test with stability augmentation OFF.	Yaw rate	OGE		Init: CT&M Rec: EM	Init: ±2°/s or ±10% Rec: EM
			Yaw rate or heading change	OGE	Init: CT&M Rec: EM		

2.d: Handling Qualities Lateral Directional		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
		CCA: Test in normal and non-normal control state For feature OGE at fidelity level G: Test in normal mode only					
2.d.7	Dutch roll	Cruise, and either approach or landing Yaw damper OFF CCA: Test in non-normal control state	Period	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±0.5 s or ±10% Rec: EM
			Time to one half or double amplitude or damping ratio	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% of time to one half or double amplitude or ±0.02 of damping ratio. Rec: EM
			Time difference between peaks of roll angle and sideslip	OGE			Init: ±1 s or ±20% Rec: EM
2.d.8	Steady state sideslip	Either approach or landing	For a given rudder position:				
			Roll angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2° Rec: EM

2.d: Handling Qualities Lateral Directional	Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
				G	R	S
		Sideslip angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1° Rec: EM
		Aileron angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2° or ±10% Rec: EM
		Spoiler or equivalent roll controller position or force	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5° or ± 10% Rec: EM
		For aeroplanes with reversible flight control systems:				
		Wheel force	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.3 daN (3 lb) or ±10% Rec: EM
		Rudder pedal force	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2.2 daN (5 lb) or ±10% Rec: EM

(a) Requirements for all the aeroplane lateral directional tests:

2.d: Handling Qualities Lateral Directional	Test requirements
All tests	1. Power setting may be that required for level flight unless otherwise specified.

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.d: Handling Qualities Lateral Directional		Test requirements
2.d.1	Minimum control speed, air (V_{MCA} or V_{MCL})	1. Test shall be performed per applicable airworthiness standard, or low-speed engine inoperative handling characteristics in the air. 2. Minimum speed may be defined by a performance or control limit which prevents demonstration of V_{MCA} or V_{MCL} in the conventional manner. 3. Take-off thrust shall be set on the operating engine(s). 4. Time history or snapshot data may be used. 5. CCA: Test in normal or non-normal control state. 6. For feature OGE at fidelity levels G and R: It is important that there exists a realistic speed relationship between V_{MCA} (or V_{MCL}) and V_S for all configurations and in particular the most critical full-power engine-out configuration.
2.d.2	Roll response (rate)	1. Test with normal roll control displacement (about one third of maximum roll controller travel). 2. This test may be combined with step input of flight deck roll controller test 2.d.3.
2.d.3	Step input of flight deck roll controller (or roll overshoot)	1. With wings level, apply a step roll control input using approximately one third of maximum roll controller travel. At approximately 20° to 30° roll angle, abruptly return the roll controller to neutral and allow at least 10 s of aeroplane free response. 2. This test may be combined with roll response (rate) test 2.d.2. 3. CCA: Test in normal and non-normal control state. 4. For feature OGE at fidelity level G: Test in normal mode only.
2.d.4	Spiral stability	1. Aeroplane data averaged from multiple tests may be used. 2. Test for both directions. 3. As an alternative test, show lateral control required to maintain a steady turn with a roll angle of approximately 30°. 4. CCA: Test in non-normal control state.
2.d.5	Engine inoperative trim	1. Test shall be performed in a manner similar to that for which a pilot is trained to trim an engine failure condition. 2. 2nd segment climb test shall be at take-off thrust. 3. Approach or landing test shall be at thrust for level flight. 4. This test may be a series of snapshot tests.
2.d.6	Rudder response	1. For feature OGE at fidelity level S and R: Test with stability augmentation ON and OFF. 2. For feature OGE at fidelity level G: Test with stability augmentation OFF.

2.d: Handling Qualities Lateral Directional		Test requirements
		3. Test with a step input at approximately 25% of full rudder pedal throw. 4. CCA: Test in normal and non-normal control state. 5. For feature OGE at fidelity level G: Test in normal mode only.
2.d.7	Dutch roll	1. Test for at least six cycles with stability augmentation OFF. 2. CCA: Test in non-normal control state.
2.d.8	Steady state sideslip	1. This test may be a series of snapshot tests using at least two rudder positions (in each direction for propeller-driven aeroplanes), one of which shall be near the maximum allowable rudder. 2. For feature OGE at fidelity level G: Roll controller position tolerance parameter instead of aileron angle may be used.

CS FSTD.QTG.A.220 Handling qualities landing - Aeroplane

This CS provides standards for the objective tests of aeroplane landing.

2.e: Handling Qualities - Landings		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.e.1	Normal landing	Landing CCA: Test in normal <u>and</u> non-normal control state, if applicable	Airspeed	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Pitch angle	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			AoA	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			Height	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3 m (10 ft) or ±10% Rec: EM
			For aeroplanes with reversible flight control systems:				
			Column force	GND, IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% or ±2.2 daN (5 lb) Rec: EM
2.e.2	Minimum flap landing	Minimum certified landing flap configuration	Airspeed	GND, IGE			Init: ±3 kts Rec: EM
			Pitch angle	GND, IGE			Init: ±1.5° Rec: EM
			AoA	GND, IGE			Init: ±1.5° Rec: EM

2.e: Handling Qualities - Landings		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Height	GND, IGE			Init: ±3 m (10 ft) or ±10% Rec: EM
			For aeroplanes with reversible flight control systems:				
			Column force	GND, IGE			Init: ±10% or ±2.2 daN (5 lb) Rec: EM
2.e.3	Crosswind landing	Landing	Airspeed	GND, IGE		Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Pitch angle	GND, IGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			AoA	GND, IGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			Height	GND, IGE		Init: CT&M Rec: EM	Init: ±3 m (10 ft) or ±10% Rec: EM
			Roll angle	GND, IGE		Init: CT&M Rec: EM	Init: ±2° Rec: EM
			Sideslip angle	GND, IGE		Init: CT&M Rec: EM	Init: ±2° Rec: EM
			Heading angle	GND, IGE		Init: CT&M Rec: EM	Init: ±3° Rec: EM

2.e: Handling Qualities - Landings		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			For aeroplanes with reversible flight control systems:				
			Column force	GND, IGE		Init: CT&M Rec: EM	Init: ±10% or ±2.2 daN (5 lb) Rec: EM
			Wheel force	GND, IGE		Init: CT&M Rec: EM	Init: ±10% or ±1.3 daN (3 lb) Rec: EM
			Rudder pedal force	GND, IGE		Init: CT&M Rec: EM	Init: ±10% or ±2.2 daN (5 lb) Rec: EM
2.e.4	One engine inoperative landing	Landing	Airspeed	GND, IGE		Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Pitch angle	GND, IGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			AoA	GND, IGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			Height	GND, IGE		Init: CT&M Rec: EM	Init: ±3 m (10 ft) or ±10% Rec: EM
			Roll angle	GND, IGE		Init: CT&M Rec: EM	Init: ±2° Rec: EM
			Sideslip angle	GND, IGE		Init: CT&M Rec: EM	Init: ±2° Rec: EM

2.e: Handling Qualities - Landings		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Heading angle	GND, IGE		Init: CT&M Rec: EM	Init: ±3° Rec: EM
2.e.5	Autopilot landing	Landing	Flare height	GND, IGE		Init: CT&M Rec: EM	Init: ±1.5 m (5 ft) Rec: EM
			Duration of flare	GND, IGE		Init: CT&M Rec: EM	Init: ±0.5 s or ±10% Rec: EM
			R/D at touchdown	GND, IGE		Init: CT&M Rec: EM	Init: ±0.7 m/s (140 ft/min) Rec: EM
			Lateral deviation during rollout	GND, IGE		Init: CT&M Rec: EM	Init: ±3 m (10 ft) Rec: EM
2.e.6	All engine autopilot go-around	As per aeroplane performance data	Airspeed	IGE		Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Pitch angle	IGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			AoA	IGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
2.e.7	One-engine-inoperative go-around	Manual go-around <u>and</u> autopilot go-around As per aeroplane performance data CCA: Test in non-	Airspeed	IGE		Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Pitch angle	IGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			AoA	IGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM

2.e: Handling Qualities - Landings		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
		normal control state	Roll angle	IGE		Init: CT&M Rec: EM	Init: ±2° Rec: EM
			Sideslip angle	IGE		Init: CT&M Rec: EM	Init: ±2° Rec: EM
2.e.8	Directional control (rudder effectiveness) with symmetric reverse thrust	Landing	Airspeed	GND		Init: CT&M Rec: EM	Init: ±5 kts Rec: EM
			Yaw rate	GND		Init: CT&M Rec: EM	Init: ±2°/s Rec: EM
2.e.9	Directional control (rudder effectiveness) with asymmetric reverse thrust	Landing	Airspeed	GND		Init: CT&M Rec: EM	Init: ±5 kts Rec: EM
			Heading angle	GND		Init: CT&M Rec: EM	Init: ±3° Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.e: Handling Qualities - Landings		Test requirements
2.e.1	Normal landing	1. Test from a minimum of 61 m (200 ft) AGL to nosewheel touchdown. 2. Two tests shall be shown, including two normal landing flaps (if applicable) one of which shall be near maximum certified landing mass, the other at light or medium mass. 3. CCA: Test in normal and non-normal control state.
2.e.2	Minimum flap landing	1. Test from a minimum of 61 m (200 ft) AGL to nosewheel touchdown. 2. Test at near maximum certified landing mass.
2.e.3	Crosswind landing	1. Test from a minimum of 61 m (200ft) AGL to a 50% decrease in main landing gear touchdown speed.

2.e: Handling Qualities - Landings		Test requirements
		2. Requires validation data, including wind profile, for a crosswind component of at least 60% of aeroplane performance data value measured at 10 m (33 ft) above the runway. 3. Wind components shall be provided as headwind and crosswind values with respect to the runway.
2.e.4	One engine inoperative landing	1. Test from a minimum of 61 m (200 ft) AGL to a 50% decrease in main landing gear touchdown speed.
2.e.5	Autopilot landing	1. If autopilot provides rollout guidance, record lateral deviation from touchdown to a 50% decrease in main landing gear touchdown speed. 2. Time of autopilot flare mode engage and main gear touchdown shall be noted.
2.e.6	All engine autopilot go-around	1. Normal all engine autopilot go-around shall be demonstrated at medium mass.
2.e.7	One-engine-inoperative go-around	1. Engine inoperative go-around required near maximum certified landing mass with critical engine(s) inoperative. 2. CCA: Non-autopilot test to be conducted in non-normal mode.
2.e.8	Directional control (rudder effectiveness) with symmetric reverse thrust	1. Apply rudder pedal input in both directions using full reverse thrust until reaching full thrust reverser minimum operating speed.
2.e.9	Directional control (rudder effectiveness) with asymmetric reverse thrust	1. With full reverse thrust on the operating engine(s), maintain heading with rudder pedal input until maximum rudder pedal input or thrust reverser minimum operating speed is reached.

CS FSTD.QTG.A.225 Handling qualities ground effect- Aeroplane

This CS provides standards for the objective tests of aeroplane ground effect handling qualities.

2.f: Handling Qualities - Ground Effect		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.f.1	Ground effect	Landing CCA: Test in normal <u>or</u> non-normal control state	Elevator	IGE		Init: CT&M Rec: EM	Init: ±1° Rec: EM
			Trim angle	IGE		Init: CT&M Rec: EM	Init: ±0.5° Rec: EM
			Net thrust or equivalent	IGE		Init: CT&M Rec: EM	Init: ±5% Rec: EM
			AoA	IGE		Init: CT&M Rec: EM	Init: ±1° Rec: EM
			Height	IGE		Init: CT&M Rec: EM	Init: ±1.5 m (5 ft) or ±10% Rec: EM
			Airspeed	IGE		Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Pitch angle	IGE		Init: CT&M Rec: EM	Init: ±1° Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.f: Handling Qualities - Ground Effect		Test requirements
2.f.1	Ground effect	1. Refer to GM1 FSTD.QTG.A.225.

2.f: Handling Qualities - Ground Effect		Test requirements
		2. A rationale shall be provided with justification of results. 3. CCA: Test in normal <u>or</u> non-normal control state.

GM1 FSTD.QTG.A.225 Ground effect - Aeroplanes

This GM provides guidance for the definition of ground effect tests parameters.

(a) For an FSTD to be used for take-off and landing, it should faithfully reproduce the aerodynamic changes which occur in ground effect. The parameters chosen for FSTD validation should be indicative of these changes.

The selection of the test method and procedures to validate ground effect is at the option of the organisation performing the flight tests; however, the flight test should be performed with enough duration near the ground to validate sufficiently the ground-effect model.

(b) Acceptable tests for validation of ground effect include the following:

(1) Level fly-bys: these should be conducted at a minimum of three altitudes within the ground effect, including one at no more than 10% of the wingspan above the ground, one each at approximately 30% and 50% of the wingspan where height refers to main gear tyre above the ground. In addition, one level-flight trim condition should be conducted out of ground effect, e.g. at 150% of wingspan.

(2) Shallow approach landing: this should be performed at a glide slope of approximately one degree with negligible pilot activity until flare.

If other methods are proposed, a rationale should be provided to conclude that the tests performed validate the ground-effect model.

If other methods are proposed, a rationale should be provided to conclude that the tests performed validate the ground-effect model.

(c) The lateral-directional characteristics are also altered by ground effect. For example, because of changes in lift, roll damping is affected. The change in roll damping will affect other dynamic modes usually evaluated for FSTD validation. Dutch roll dynamics, spiral stability, and roll-rate for a given lateral control input are altered by ground effect. Steady heading sideslips will also be affected. These effects should be accounted for in the FSTD modelling. Several tests such as 2.e.3 Crosswind landing, 2.e.4 One engine inoperative landing, and 1.b.5 Engine failure on take-off serve to validate lateral-directional ground effect since portions of them are accomplished whilst transiting heights at which ground effect is an important factor.

CS FSTD.QTG.A.230 Windshear demonstration - Aeroplane

This CS provides standards for the objective tests of aeroplane windshear demonstration.

2.g: Windshear demonstration		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.g.1	Windshear demonstration	Take-off, and landing	N/A	GND, IGE, OGE		Init: N/A Rec: EM	Init: N/A Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.g: Windshear demonstration	Test requirements
All tests	1. Four tests are required, two in the take-off condition and two in the landing condition. For the two tests in each condition, one shall be conducted to baseline the FSTD performance in still air, and the second test to demonstrate the effects of the active windshear model relative to the baseline test. 2. The test shall utilise the windshear model(s) as described in the Statement of Justification required in CS FSTD.QB.113, para 13.5.2. The test shall include a rationale that describes the windshear effects being demonstrated. 3. The tests shall be evaluated for characteristic effects on relevant aerodynamic and other parameters, such as angle of attack, control inputs, and thrust/power settings.

CS FSTD.QTG.A.235 Flight and manoeuvre envelope protection functions - Aeroplane

This CS provides standards for the objective tests of aeroplane flight and manoeuvre envelope protection functions.

2.h: Handling Qualities - Flight and Manoeuvre Envelope Protection Functions		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.h.1	Overspeed	Cruise CCA: Test in normal <u>and</u> non-normal control state, if function is different	Airspeed	OGE		Init: CT&M Rec: EM	Init: ±5 kt Rec: EM
2.h.2	Minimum speed	Take-off, cruise, and either approach or landing CCA: Test in normal <u>and</u> non-normal control state, if function is different	Airspeed	OGE		Init: CT&M Rec: EM	Init: ±3 kt Rec: EM
2.h.3	Load factor	Take-off, and cruise CCA: Test in normal <u>and</u> non-normal control state, if function is different	Normal acceleration	OGE		Init: CT&M Rec: EM	Init: ±0.1 g Rec: EM
2.h.4	Pitch angle	Cruise, and	Pitch angle	OGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM

2.h: Handling Qualities - Flight and Manoeuvre Envelope Protection Functions		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
		approach CCA: Test in normal and non-normal control state, if function is different					
2.h.5	Bank angle	Approach CCA: Test in normal and non-normal control state, if function is different	Roll angle	OGE		Init: CT&M Rec: EM	Init: ±2° or ±10% Rec: EM
2.h.6	Angle of attack	Second segment climb, and either approach or landing CCA: Test in normal and non-normal control state, if function is different	AoA	OGE		Init: CT&M Rec: EM	Init: ±1.5° Rec: EM

(a) Requirements for all the aeroplane fight and manoeuvre envelope protection functions:

2.h: Handling Qualities - Flight and Manoeuvre Envelope Protection Functions	Test requirements
All tests	1. These are only applicable to computer-controlled aeroplanes. 2. Time history results of response to control inputs during entry into each envelope protection function (i.e. with normal and degraded control states, if function is different) are required. 3. Set thrust as required to reach the envelope protection function.

CS FSTD.QTG.A.240 Engine and airframe icing effects demonstration - Aeroplane

This CS provides standards for the objective tests of aeroplane Engine and Airframe Icing effects demonstration.

2.i: Handling Qualities - Engine and Airframe Icing Effects		**Test Conditions**	**Tolerance Parameter**	**Primary Feature(s) Validated**	**Tolerances**		
					G	**R**	**S**
2.i.1	Engine and airframe icing effects demonstration (high angle of attack)	Either take-off or approach or landing	N/A	OGE			Init: N/A Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.f: Handling Qualities - Engine and Airframe Icing Effects		**Test requirements**
2.i.1	Engine and airframe icing effects demonstration (high angle of attack)	1. The tests shall be time histories starting from a trimmed condition through approach to stall, full stall, and initiation of the recovery. a. The full stall portion of the manoeuvre is only required for those FSTDs that are to be qualified for full-stall training tasks. 2. Two tests are required, both at the same test condition. One test to baseline the FSTD performance without ice accretion, and the second test to demonstrate the characteristic engine and aerodynamic airframe icing effects caused by in-flight ice accretion relative to the baseline test. a. The test with ice accretion shall be conducted by initialising and maintaining a fixed amount of ice accretion throughout the manoeuvre in order to consistently evaluate the icing effects.

2.f: Handling Qualities - Engine and Airframe Icing Effects		Test requirements
		3. The tests shall utilise the icing model(s) as described in the Statement of Justification required in CS FSTD.QB.107, para 7.2.2. The tests shall include a description of 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). 4. The tests shall be evaluated for characteristic effects on relevant aerodynamic and other parameters, such as angle of attack, control inputs, and thrust/power settings. 5. Plotted parameters shall include the following as a minimum: 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 6. Flight test validation data is not required.

CS FSTD.QTG.A.300 Motion system - Aeroplane

This CS provides standards for the objective tests of aeroplane motion system.

3.a-f: Motion System		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
3.a	Frequency response	N/A	As specified by the applicant for FSTD qualification	MTN		Init: As specified by the applicant for FSTD qualification Rec: Same as Init	Init: As specified by the applicant for FSTD qualification Rec: Same as Init
3.b	Leg balance	N/A	Phase shift (each motion jack compared to a datum jack)	MTN		Init: Phase shift as specified by the applicant for FSTD qualification Rec: Same as Init	Init: Phase shift as specified by the applicant for FSTD qualification Rec: Same as Init
3.c	Turn-around check	N/A	Deviation from the desired sinusoidal acceleration	MTN		Init: 0.05 g Rec: Same as Init	Init: 0.05 g Rec: Same as Init
3.d	Reserved						
3.e	Motion system repeatability	On ground, and in flight	Actual motion platform linear accelerations	MTN		Init: N/A Rec: ±0.05 g actual motion platform linear accelerations	Init: N/A Rec: ±0.05 g actual motion platform linear accelerations
3.f	Motion cueing performance signature	See Test requirements table below for 3.f	Correlation between motion cueing and aircraft simulation model	MTN			Init: CT&M Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

3.a-f: Motion System		Test requirements
3.a	Frequency response	1. The test shall demonstrate the motion frequency response for an oscillatory input, for each linear and rotational axis. 2. The test shall cover at least frequencies between 0.1 Hz to 15 Hz. 3. The test shall be run independent of the motion cueing software and is to be considered as a robotic test. 4. Plots of phase and attenuation shall be plotted against the frequency of the motion movement. 5. The motion movement shall be measured (e.g. by using an accelerometer) and not computed from the leg positions. 6. The tolerances have been left to the discretion of the applicant for the FSTD qualification. The selected tolerances shall be set to demonstrate the performance of the motion system hardware, and to check the integrity of the motion set-up with regard to calibration and wear. The statement of justification shall explain how the tolerances have been determined.
3.b	Leg balance	1. For the leg balance method, the phase shift between a datum jack and any other jack shall be measured using a heave (vertical) signal of 0.5 Hz at ±0.25 g.
3.c	Turn-around check	1. The test shall demonstrate the motion response during oscillatory manoeuvres does not exhibit excessive noise by driving each motion actuator with a sinusoidal signal and recording the motion movement. 2. The motion base shall be driven sinusoidally in the heave axis through a displacement of 150 mm peak to peak at a frequency of 0.5 Hz. 3. The motion movement shall be measured (e.g. by using an accelerometer) and any deviation compared to the command signal. 4. The test shall be run independent of the motion cueing software and is to be considered as a robotic test.
3.e	Motion system repeatability	1. The test shall demonstrate that the motion system hardware and software, in normal FSTD operating mode, continue to perform as initially qualified, i.e. to demonstrate that the motion system software and motion system hardware have not degraded or changed over time. 2. The test inputs shall be such that both rotational accelerations/rates and linear accelerations are inserted before the transfer from aeroplane centre of gravity to pilot reference point with a minimum amplitude of 5°/s/s, 10°/s and 0.3g respectively to provide adequate analysis of the output. 3. Two tests shall be performed, one in an on-ground state and the other in an in-air state. This is to cater for possible differences in motion system gains for the on-ground and in-air conditions. The exact test conditions are to be

<table>
<tr><th colspan="2">3.a-f: Motion System</th><th>Test requirements</th></tr>
<tr><td></td><td></td><td>determined by the applicant for FSTD qualification.
4. Parameters to be plotted are:
a. the acceleration commands;
b. actual linear acceleration measured from accelerometers at the pilot position (the output will comprise accelerations due to both the linear and rotational motion accelerations);
c. motion actuator positions; and
d. the motion system attitude and position (i.e. pitch, roll, yaw, surge, sway, heave).</td></tr>
<tr><td>3.f</td><td>Motion cueing performance signature</td><td>1. A Statement of Justification shall explain the motion movements and give basis for their magnitude and correlation for each test for each axis.
2. Parameters to be plotted:
a. Flight parameters;
b. Motion platform movements on all six axis (i.e. pitch, roll, yaw, heave, sway, and surge);
c. Motion actuator movements; and
d. Correlation of motion cueing with respect to the aircraft simulation model in terms of acceleration and angular rates by overplotting. This plotting shall be done on all the applicable axes for the test (i.e. for the key acceleration and angular cues).

The table below defines the required test cases for an FSTD having each of the aircraft simulation features at fidelity levels G, R or S. If any of those features are at fidelity level N, the tests applicable to the FSTD shall be agreed with the competent authority.
<table>
<tr><th>No.</th><th>Test</th><th>Demonstration method</th><th>Key acceleration and angular cues</th></tr>
<tr><td>1</td><td>Taxiing turn</td><td>Test to demonstrate motion cueing for taxiing turn. Inputs and flight parameters as in the test 1.a.1 Minimum radius turn.</td><td>● Entry into turn
● Long term centripetal acceleration due to turning</td></tr>
</table></td></tr>
</table>

3.a-f: Motion System		Test requirements			
		2	Take-off to V2	Test to demonstrate motion cueing for a normal take-off. Inputs and flight parameters as in the test 1.b.4 Normal take-off.	• Long term X-axis acceleration due to CAS increase • Pitch rate for rotation • Vertical acceleration (G) due to lift-off trajectory
		3	Brake release and initial acceleration	Test to demonstrate motion cueing for a take-off with thrust against brake followed by a sudden brake release. This test may be combined with the take-off test.	• Initial X-axis acceleration due to CAS increase • Long term X-axis acceleration due to CAS increase
		4	Rejected take-off (engine failure prior to V1)	Test to demonstrate motion cueing for a rejected take-off. Inputs and flight parameters as in the test 1.b.7 Rejected take-off.	• Initial X-axis deceleration due to CAS decrease • Long term X-axis deceleration due to CAS decrease
		5	Engine failure in the air	Test to demonstrate motion cueing for an engine failure. Inputs and flight parameters as in the test 1.b.8 Dynamic engine failure after take-off. CCA: Test in non-normal control state.	• All the angular rates due to yaw, bank and pitch changes of the aircraft
		6	Steady-state climb	Test to demonstrate motion cueing for steady-state climb. Inputs and flight parameters as in the test 1.c.1 Normal climb all engines operating.	• Pitch attitude of the aircraft
		7	Level flight acceleration	Test to demonstrate motion cueing for level flight acceleration. Inputs and flight parameters as in the test 1.d.1 Level flight acceleration.	• Initial X-axis acceleration due to IAS increase • Long term X-axis acceleration due to CAS increase

3.a-f: Motion System		Test requirements			
		8	Level flight deceleration	Test to demonstrate motion cueing for level flight acceleration. Inputs and flight parameters as in the test 1.d.2 Level flight deceleration.	• Initial X-axis deceleration due to CAS decrease • Long term X-axis deceleration due to CAS decrease
		9	Power change dynamics	Tests to demonstrate motion cueing for power changes. Inputs and flight parameters as in the test 2.c.1 Power change dynamics. CCA: Test in non-normal control state.	• Pitch rate • Long term X-axis acceleration/deceleration due to CAS changes • If applicable: yaw rate of the aircraft due to asymmetric thrust (e.g. single engine aircraft)
		10	Configuration changes, flaps	Test to demonstrate motion cueing for configuration changes. Inputs and flight parameters as in the test 2.c.2 Flap change dynamics. CCA: Test in non-normal control state.	• Pitch rate • Long term X-axis acceleration/deceleration due to CAS changes
		11	Configuration changes, landing gear	Tests to demonstrate motion cueing for configuration changes. Inputs and flight parameters as in the test 2.c.4 Gear change dynamics. CCA: Test in non-normal control state.	• Pitch rate • Long term X-axis acceleration/deceleration due to CAS changes
		12	Turns	Test to demonstrate motion cueing for turns in the air. Inputs and flight parameters as in the test 2.d.3 Step input of flight deck roll controller (or roll overshoot).	• Entry into turn • Long term turning cue
		13	Rudder response	Test to demonstrate motion cueing for rudder response in the air. Inputs and flight parameters as	• Yaw rate of the aircraft

3.a-f: Motion System		Test requirements			
				in the test 2.d.6 Rudder response.	
		14	Landing	Test to demonstrate motion cueing for normal landing. Inputs and flight parameters as in the test 2.e.1 Normal landing.	• Pitch attitude of the aircraft during final approach • Pitch for flare • Heave bumps (G) due to landing gear touchdowns
		15	Go-around	Test to demonstrate motion cueing for a go-around. Inputs and flight parameters as in the test 2.e.6 All engine autopilot go-around. If the simulated aircraft is not equipped with an autopilot, then the test inputs and flight parameters are to be flown as for a normal go-around profile.	• Pitch rate for rotation • Vertical acceleration (G) due to trajectory

GM1 FSTD.QTG.A.300 Motion cueing performance signature tests

This GM gives guidance on the motion cueing performance signature tests for the Motion Cueing feature at Specific fidelity level.

Pilots use continuous information signals to regulate the state of the aircraft. In concert with the instruments and outside-world visual information, whole-body motion feedback is essential in assisting the pilot to control the aircraft’s dynamics, particularly in the presence of external disturbances. The motion system should therefore meet basic objective performance criteria, as well as being subjectively tuned at the pilot's seat position to represent the linear and angular accelerations of the aircraft during a prescribed minimum set of manoeuvres and conditions. Moreover, the response of the motion cueing system should be repeatable.

The motion cueing performance signature tests provide objective evidence of the motion movements for different manoeuvres. The purpose of these tests is to demonstrate that the motion is giving appropriate cueing, and that the motion cueing remains the same as time passes. For the Motion Cueing feature at fidelity level S, the motion system should provide high tilt coordination gain, high rotational gain, and high correlation with respect to the aircraft simulation model.

Realistic motion cueing requires among other things adequate motion movement envelope, capability to do quick motion movements and good motion cueing algorithms. The movement envelope is limited by the physical dimensions (e.g. stroke length) and geometry (e.g. attachment points of the legs). A Stewart platform is a widely used six degrees of freedom motion system platform. Such motion systems are capable of tilting (pitch, roll) the flight deck to approximately the same tilt angle regardless of the leg stroke length. But the stroke length has a clear impact on the translation (surge, sway, heave) and yaw envelope - the shorter the stroke, the shorter the achievable translation and yaw excursion.

The pilot seats are typically located well above the motion centroid which means that the pilots are situated on top of a 'lever arm'. When the flight deck is tilted backwards, the pilots also move backwards. In other words, the motion movement has cross-coupling - movement on one axis generates a movement on another axis. Humans are able to register all these movements, so the unwanted cross-coupling needs to be compensated by translating the motion system together with the tilting. This is done by the motion cueing algorithms. It is laborious to tune the motion algorithms to provide only correct cues, still with maximum level of cueing. The motion cueing algorithms may use only a portion of the motion's physical envelope but may as well use the whole envelope especially for certain manoeuvres (e.g. helicopter autorotation). The motion cueing performance signature tests should demonstrate that the motion provides adequate cueing and the motion cueing uses the motion envelope to the maximum extent possible, as required by the General Requirements in CS FSTD.QB.110.

The motion gives short term cues (e.g. due to change in aircraft attitude) and long term cues (e.g. due to airspeed acceleration). The long term cue for airspeed acceleration for an aeroplane FSTD is to tilt the flight deck backwards to use the gravity to create the sensation of forward acceleration (see Figure 1). The motion can't maintain large excursions for a prolonged time, because it has to be ready for the next movement that could require more displacement. When an aeroplane is stationary on the runway with take-off thrust applied against the brakes and the brakes are suddenly released, the motion system typically does the following. The motion moves forwards to give an initial cue for a forward acceleration. Simultaneously, the motion tilts backwards to give a sustained long term cue for the forward acceleration. Soon after the tilting is performed, the motion may begin a 'washout'. This means that the motion returns slowly towards neutral. This is done at such a low rate that a human does not notice it, especially when the other cues (e.g. visual, sounds, instruments) are supporting the feel of the acceleration continuing. For sway and surge axes, depending on the chosen compromise within the cueing algorithm and on the amplitude of the aircraft acceleration, the cueing algorithm can either favour a high initial acceleration that is close to aircraft initial acceleration at the expense of reducing the maintained acceleration cues when washout activates, or it can favour the same acceleration trend as the aircraft without reducing acceleration cues during washout at the expense of a reduced initial acceleration. The short and long term cues and washout can directly be seen in the graphs of the motion cueing performance signature tests. The motion cannot tilt too quickly since the human vestibular system is able to feel angular rates above a perception threshold and may feel sick or disoriented if the motion platform tilting rate is above this threshold, being not consistent with the visual cues. The motion platform pitch and roll angles should also be limited to appropriate values since humans are able not only to feel significant angular rates, but also large attitudes.

Additional information can be found, among other sources, in R. J. Telban *A Nonlinear Motion Cueing Algorithm with a Human Perception Model*, PhD. report from State University of New York at Binghamton, Department of Mechanical Engineering.

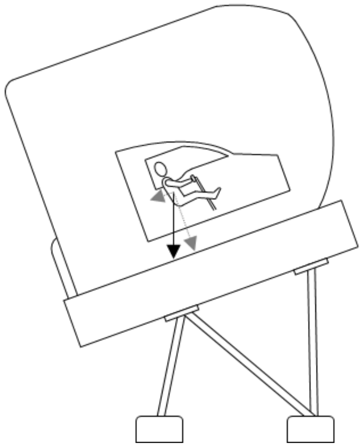

Figure 1. Motion system tilted backwards to use the component of the gravity vector in forward acceleration cueing.

Example

The figures below show an example of motion cueing performance signature test for an aeroplane FSTD take-off. This example shows the FSTD result from the QTG that is to be delivered to the competent authority for the purpose of becoming the MQTG. The future recurrent test results would then be compared to the MQTG result to ensure that no change in the motion cueing has happened.

The inputs in this test are the aircraft flight parameters, and the output is the motion movement. These tests should show graphs of all the applicable flight parameters (e.g. airspeed, pitch attitude, bank angle, heading, flight control positions, altitude, thrust, etc.) and the motion movement (e.g. motion translations and tilt angles), and comparison between commanded acceleration and the acceleration cue provided by the motion system.

The flight parameters should match the validation data. Figure 2 for airspeed shows the airspeed. Figure 3 for pitch attitude shows that the rotation is initiated at about 23 seconds. These graphs show that the FSTD matches the validation data. Figure 4 for the motion platform pitch attitude shows the tilt angle of the flight deck. It can be seen that when the forward acceleration begins (i.e. indicated airspeed starts increasing), the motion tilts backwards and uses gravity to give a cue of forward acceleration. The tilt angle depends on the motion cueing algorithms, but also on the conditions (e.g. weight of aircraft, density altitude) and configuration (e.g. thrust, flaps, etc.). If the tilt angle would be too low, the pilots would not sense adequate feel of acceleration. The washout begins at about 12 seconds. The tilt is slowly returned towards the neutral position to be ready to give a short term cue for rotation, i.e. pitch angle change at about 24 seconds.

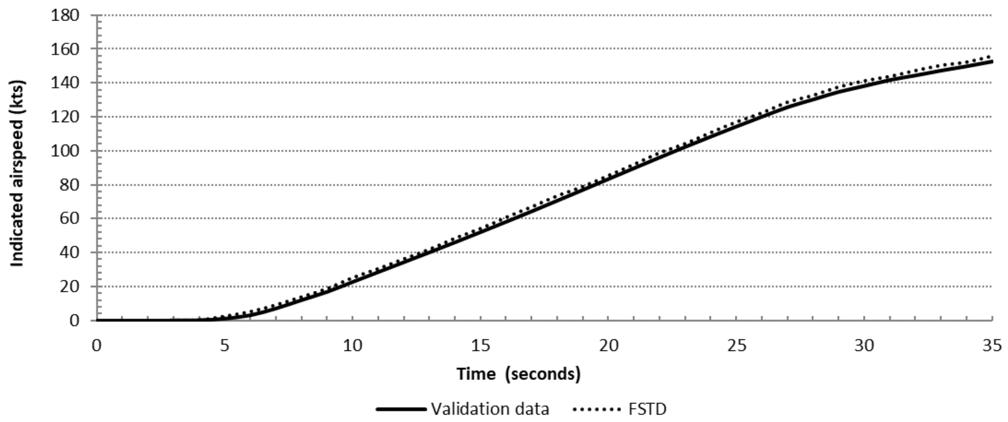

Figure 2. Aeroplane airspeed angle during take-off

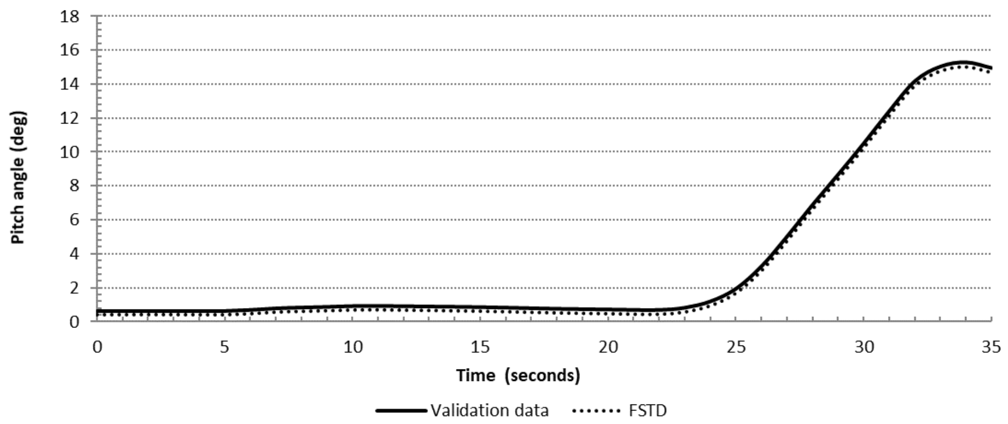

Figure 3. Aeroplane pitch angle during take-off

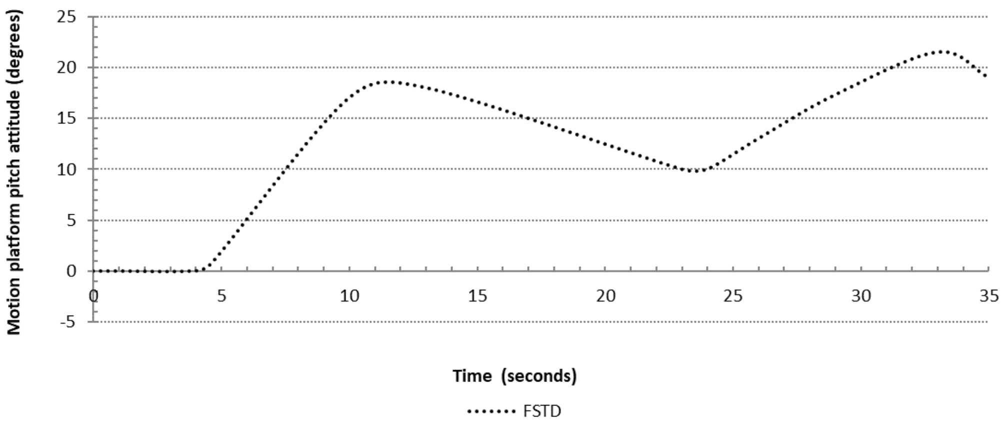

Figure 4. Motion system platform tilting on the pitch axis for aeroplane take-off

Figures 2 through 4 demonstrate that the motion cueing has the expected elements for short term and long term cueing (i.e. high-pass and low-pass filters of the motion cueing algorithms) and washout. The motion cueing must also have high correlation with respect to the aircraft simulation model. This can be demonstrated by overlaying the plots of the aircraft acceleration and the acceleration cue to the pilots. The aircraft acceleration (i.e. acceleration command) is directly given by the flight dynamics model. The acceleration cue given to the pilots can be measured by using accelerometers in the FSTD, or it can be derived from the attitude and position of the motion system (see two components of the gravity vector in figure 1).

Figure 5 shows the plot for the long term cueing correlation for this example. The time-history is cut to show only the long term portion (i.e. acceleration cue before the rotation). The solid line shows the forward acceleration (X axis) as calculated by the flight model. The dotted line shows the long term forward acceleration cue provided by tilting the motion system backwards. Figure 5 demonstrates that the trend and timing has high correlation and the maximum magnitude (i.e. at 11 seconds before the washout) of the forward acceleration is realistic in this example. While this correlation has no numerical tolerances, the cueing should have high correlation with respect to the aircraft simulation model. The cueing depends on the platform excursion limits and the cueing algorithms may keep some margin for further acceleration changes. Also, the motion cueing algorithms may not use a washout for all the axes but use a deliberately lower but sustained cue. These factors may lower the correlation between the two graphs and the Statement of Justification should give basis for the magnitude and correlation.

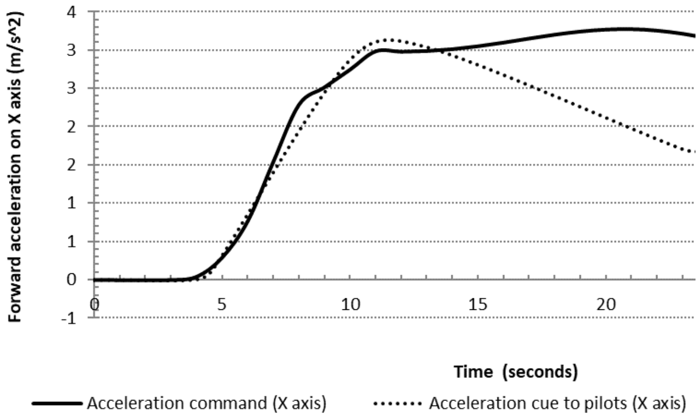

Figure 5. Correlation between the commanded acceleration and the long term motion cue

Similar correlation graphs for the translations and short term cueing (e.g. rotation in this example) should also demonstrate high correlation for other key acceleration and angular cues. For example, figure 4 shows that the motion pitch rate and magnitude for rotation (after 24 seconds) matches figure 3, so a high correlation can be seen. Note that angular rates (i.e. slope of figure 4 between about 25-32 seconds) and their duration (in figure 4 between about 25-32 seconds) are important for motion cueing.

The FSTDs and motion systems are different. The shape of the motion movement time-histories are different for each device but they should demonstrate the aspects presented above. Similar aspects have to be considered in the assessment of all the motion cueing performance signature tests. These aspects should also be noted while doing functions and subjective testing.

GM2 FSTD.QTG.A.300 Assessment of the motion cueing performance signature tests

This GM gives guidance on assessment of the motion cueing performance signature tests for the Motion Cueing feature at Specific fidelity level.

The tolerances for the tests are specified as Correct Trend and Magnitude (CT&M) in CS FSTD.QTG.A.300. When a washout is employed, the motion cueing deviates from the acceleration commanded by the flight model. Consequently, if the correlation between motion cueing and aircraft simulation model is shown for the whole time history, it should be understood that the motion cueing differs from the acceleration of the simulated aircraft due to the washout. The Statement of Justification should explain these.

The test assessment should be on the correlation between motion cueing and aircraft simulation model only for the time periods with significant changes in the commanded accelerations during the tests. An illustrative example can be seen in figure 5 of GM2 FSTD.QTG.A.300, which displays part of the aeroplane take-off test correlation between the commanded acceleration and the long-term motion cue for the forward acceleration. The focus in this graph is for the period between about 3 and 13 seconds. This is the moment of the significant changes in the commanded acceleration and the correlation between motion cueing and aircraft simulation model should demonstrate CT&M for this period. Similarly for other significant changes.

The significant changes in the commanded accelerations are those described as the 'key acceleration and angular cues' in CS FSTD.QTG.A.300. During initial qualification, the correlation between motion cueing and the aircraft simulation model should demonstrate CT&M. For recurrent tests, they should exhibit Essential Match.

For more guidance on CT&M, refer to GM1 CS FSTD.ENG.020.

CS FSTD.QTG.A.305 Characteristic motion vibrations/buffet

This CS provides standards for the objective tests of aeroplane characteristic motion vibrations which can be sensed at the flight deck where applicable by aeroplane type.

3.g: Characteristic Motion Vibrations		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
3.g.1	Thrust effects with brakes set	Ground	Frequency of vibration	VIB		Init: CT&M Rec: Same as Init	Init: The FSTD shall exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency 'spikes' being present within ±2 Hz of the aeroplane data Rec: Same as Init
3.g.2	Landing gear extended buffet	Flight	Frequency of vibration	VIB		Same as 3.g.1	Same as 3.g.1
3.g.3	Flaps extended buffet	Flight	Frequency of vibration	VIB		Same as 3.g.1	Same as 3.g.1
3.g.4	Speed brake deployed buffet	Flight	Frequency of vibration	VIB		Same as 3.g.1	Same as 3.g.1
3.g.5.a	Stall buffet (Applicable only for	Cruise (high altitude), second-	Frequency of vibration	VIB			Same as 3.g.1

3.g: Characteristic Motion Vibrations		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
	those FSTDs that are to be qualified for full stall training tasks)	segment climb, and either approach or landing					
3.g.5.b	Approach-to-stall buffet	See test requirements	Frequency of vibration	VIB		Same as 3.g.1	Same as 3.g.1
3.g.6	High speed or Mach buffet	Flight	Frequency of vibration	VIB		Same as 3.g.1	Same as 3.g.1
3.g.7	In-flight vibrations	Flight in clean configuration	Frequency of vibration	VIB		Same as 3.g.1	Same as 3.g.1

(a) Requirements for all the aeroplane vibration tests:

3.g: Characteristic Motion Vibrations	Test requirements
All tests	1. The tests shall validate amplitude vs. frequency. Tests shall cover a frequency range of at least 1 to 20 Hz. 2. Acceleration power spectral density against frequency (APSD in grms^2/Hz) for the X, Y and Z axes shall be plotted. 3. If the amplitude on any axis is negligible, its plots may be ignored provided that the statement of justification explains this. 4. The tolerances “at least three (3) of the predominant frequency ‘spikes’ being present within ±2 Hz of the aeroplane data” means that at least one spike at low-frequency range (1-4 Hz), mid-frequency range (4-10 Hz) and high-frequency range (10-25 Hz) shall be present within ±2 Hz of the aeroplane data. However, if the predominant frequencies of the aeroplane are close to each other, e.g. all the spikes in the same mid-frequency range, then the three dominant spikes shall be present within ±2 Hz of the aeroplane data. 5. The recurrent tests have the same tolerances as the initial evaluation. The recurrent tests are also expected to have very similar results as the MQTG. It is acknowledged that the vibration test results may have some variation when

3.g: Characteristic Motion Vibrations	Test requirements
	compared to the MQTG due to the random nature of the vibration/buffet and due to the mathematical process used to plot the amplitude against frequency (i.e. Fourier transformation). 6. The tests may give the test conditions and flight parameters as numerical snapshot values, ensuring that flight phases are stable. 7. For the feature VIB at fidelity level S: ○ The validation data and FSTD results shall be produced using comparable data analysis techniques. The recorded test results for characteristic buffets shall allow the comparison of relative amplitude versus frequency. ○ See GM1 FSTD.QTG.A.305. 8. For the feature VIB at fidelity level R: ○ Footprint tests only are required.

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

3.g: Characteristic Motion Vibrations		Test requirements
3.g.1	Thrust effects with brakes set	1. The test shall be conducted at maximum possible thrust with brakes set.
3.g.2	Landing gear extended buffet	1. Test condition shall be for a normal operational speed and not at the gear limiting speed.
3.g.3	Flaps extended buffet	1. Test condition shall be for a normal operational speed and not at the flap limiting speed.
3.g.4	Speed brake deployed buffet	1. Test condition shall be at a typical speed for speed brake extension.
3.g.5.a	Stall buffet (Applicable only for those FSTDs that are to be qualified	1. Test required only for FSTDs that are to be qualified for full-stall training tasks. 2. Tests shall 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. 3. Test results may be displayed as snapshots for a sample of relevant angle of attack conditions (buffet threshold of

3.g: Characteristic Motion Vibrations		Test requirements
	for full stall training tasks)	perception, initial buffet, buffet onset, stall angle of attack). 4. If stabilised flight data between buffet threshold of perception and stall angle of attack are not available, PSD analysis shall be conducted for a time span between initial buffet and stall angle of attack.
3.g.5.b	Approach-to-stall buffet	1. Test required only for FSTDs that are not to be qualified for full-stall training tasks. 2. Test required only for those aeroplanes for which approach-to-stall buffet is the first indication of an impending stall event (e.g. approach-to-stall buffet occurs before the activation of the stall warning system). 3. Test conditions shall be where approach-to-stall buffet is the first indication of an impending stall event. 4. Test shall be conducted for an angle of attack range between the buffet threshold of perception to the pilot and the initial buffet. 5. Test results may be displayed as snapshots for a sample of relevant angle of attack conditions (buffet threshold of perception, initial buffet). 6. If stabilised flight data between buffet threshold of perception and initial buffet are not available, PSD analysis shall be conducted for a time span around the occurrence of initial buffet.
3.g.6	High speed or Mach buffet	1. Test condition shall be for high-speed manoeuvre buffet/wind-up-turn or alternatively Mach buffet.
3.g.7	In-flight vibrations	1. The test shall be conducted to be characteristic of in-flight vibrations for propeller-driven aeroplanes.

GM1 FSTD.QTG.A.305 Characteristic motion vibrations

(a) Presentation of results

The characteristic motion vibrations/buffets are a means to verify that the FSTD can reproduce the frequency content of the aircraft when flown in particular conditions. The test results should be presented as a power spectral density (PSD) plot with frequencies on the horizontal axis and amplitude on the vertical axis. The aircraft data and FSTD data should be presented in the same format with the same scaling. The algorithms used for generating the FSTD data should be the same as those used for the aircraft data. If they are not the same, then the algorithms used for the FSTD data should be proven to be sufficiently comparable. As a minimum, the results along the dominant axes should be presented and a rationale for not presenting the other axes should be provided.

(b) Interpretation of results

The overall trend of the PSD plot should be considered while focusing on the dominant frequencies. Humans are particularly sensitive to vibratory accelerations occurring in the frequency range from 1-10 Hz so the most emphasis of test assessment should be on this range. Less emphasis should be placed on the differences at the high-frequency and low-amplitude portions of the PSD plot.

During the analysis, it should be considered that certain structural components of the FSTD have resonant frequencies that are filtered and thus may not appear in the PSD plot. If such filtering is required, the notch filter bandwidth should be limited to 1 Hz to ensure that the buffet feel is not adversely affected. In addition, the statement of justification should explain this and confirm that the characteristic motion vibration is not being adversely affected by the filtering.

The amplitude should match the aircraft data as per the description below. However, if for subjective reasons the PSD plot was altered, the statement of justification should note this. The human pilot can perceive vibrations over an energy range of several orders of magnitude, and so the power spectrum plots are normally rectilinear displays of log-magnitude versus frequency. A 1×10^{-3} $grms^2/Hz$ would describe a heavy buffet. On the other hand, a 1×10^{-6} $grms^2/Hz$ buffet is barely perceivable but may represent a buffet at low speed. The previous two examples could differ in magnitude by 1000. On a PSD plot this represents three decades (one decade is a change in order of magnitude of 10; two decades is a change in order of magnitude of 100, etc.).

CS FSTD.QTG.A.400 Visual display system - Aeroplane

This CS provides standards for the objective tests of aeroplane FSTD visual display system.

4.a: Visual Scene Quality		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
4.a.1	Visual field of view	N/A	Horizontal and vertical continuous field of view	VIS	Init: Visual field-of-view for each pilot with a minimum of 45° horizontally and 30° vertically, unless restricted by the type of aeroplane, simultaneously for each pilot Rec: EM	Init: Cross-cockpit visual display providing each pilot with a minimum of 200° horizontal and 40° vertical continuous field of view Rec: EM	Init: Cross-cockpit collimated visual display providing each pilot with a minimum of 200° horizontal and 40° vertical continuous field of view Rec: EM
4.a.2.a	System geometry – image position	N/A	Centre of the image	VIS		Init: From each eyepoint position, the centre of the image is between 0° and 2° inboard in the horizontal plane and within +/-0.25° vertically The difference between the left	Init: From each eyepoint position, the centre of the image is between 0° and 2° inboard in the horizontal plane and within +/-0.25° vertically The difference between the left

4.a: Visual Scene Quality		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
						and right horizontal angles shall not exceed 1° Rec: EM	and right horizontal angles shall not exceed 1° Rec: EM
4.a.2.b	System geometry – absolute geometry	N/A	All points	VIS		Init: Within the central 200° x 40°, all points on a 5° grid shall fall within 3° of the design position as measured from each pilot eyepoint Rec: EM	Init: Within the central 200° x 40°, all points on a 5° grid shall fall within 3° of the design position as measured from each pilot eyepoint Rec: EM
4.a.2.c	System geometry – relative geometry	N/A	Relative position from one point to the next	VIS		Init: Measurements of relative dot positions shall be made every 5° In the area from -10° to the lowest visible point at 15° azimuth inboard, 0°, 30°, 60° and 90°	Init: Measurements of relative dot positions shall be made every 5° In the area from -10° to the lowest visible point at 15° azimuth inboard, 0°, 30°, 60° and 90°

4.a: Visual Scene Quality		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
						outboard for each pilot position, vertical measurements shall be made every 1° to the edge of the visible image The relative position from one point to the next shall not exceed: Zone 1: 0.075°/degree; Zone 2: 0.15°/degree; Zone 3: 0.2°/degree Rec: EM	outboard for each pilot position, vertical measurements shall be made every 1° to the edge of the visible image The relative position from one point to the next shall not exceed: Zone 1: 0.075°/degree; Zone 2: 0.15°/degree; Zone 3: 0.2°/degree Rec: EM
4.a.3	Surface resolution (object detection)	N/A	Surface resolution	VIS	Init: Not greater than 4 arc minutes Rec: Same as Init	Init: Not greater than 3 arc minutes Rec: Same as Init	Init: Not greater than 2 arc minutes Rec: Same as Init
4.a.4	Lightpoint size	N/A	Lightpoint size	VIS	Init: Not greater than 8 arc minutes Rec: Same as Init	Init: Not greater than 8 arc minutes Rec: Same as Init	Init: Not greater than 5 arc minutes Rec: Same as Init

4.a: Visual Scene Quality		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
4.a.5	Raster surface contrast ratio	N/A	Raster surface contrast ratio.	VIS	Init: Not less than 4:1 Rec: Same as Init	Init: Not less than 5:1 Rec: Same as Init	Init: Not less than 8:1 Rec: Same as Init
4.a.6	Lightpoint contrast ratio	N/A	Lightpoint contrast ratio.	VIS	Init: Not less than 8:1 Rec: Same as Init	Init: Not less than 10:1 Rec: Same as Init	Init: Not less than 25:1 Rec: Same as Init
4.a.7	Light point brightness	N/A	Light point brightness.	VIS		Init: Not less than 20 cd/m^2 (5.8 ft-lamberts) Rec: Same as Init	Init: Not less than 20 cd/m^2 (5.8 ft-lamberts) Rec: Same as Init
4.a.8	Surface brightness	N/A	Surface brightness	VIS		Init: Not less than 14 cd/m^2 (4.1 ft-lamberts) on the display Rec: Same as Init	Init: Not less than 20 cd/m^2 (5.8 ft-lamberts) on the display Rec: Same as Init
4.a.9	Black level and sequential contrast	N/A	Black intensity	VIS		Init: Background brightness – black polygon brightness < 0.015 cd/m^2 (0.004 ft-lamberts) Rec: Same as Init	Init: Background brightness – black polygon brightness < 0.015 cd/m^2 (0.004 ft-lamberts) Rec: Same as Init
			Sequential contrast	VIS		Init: Maximum brightness – (background brightness – black	Init: Maximum brightness – (background brightness – black

4.a: Visual Scene Quality		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
						polygon brightness) > 2000:1 Rec: Same as Init	polygon brightness) > 2000:1 Rec: Same as Init
4.a.10	Motion blur	N/A	Pattern gap	VIS		Init: When a pattern is rotated about the eyepoint at 10°/s, the smallest detectable gap shall be 6 arc min or less Rec: Same as Init	Init: When a pattern is rotated about the eyepoint at 10°/s, the smallest detectable gap shall be 4 arc min or less Rec: Same as Init
4.a.11	Speckle test	N/A	Speckle contrast	VIS		Init: Speckle contrast shall be < 10% Rec: Same as Init	Init: Speckle contrast shall be < 10% Rec: Same as Init

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

4.a: Visual Scene Quality		Test requirements
4.a.1	Visual field of view	1. Field of view shall be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5° squares. 2. Installed alignment shall be confirmed in an SOJ (this would generally consist of results from acceptance testing). 3. For feature VIS at fidelity level G: 30° vertical field of view may be insufficient to meet the requirements of the visual ground segment (if required). This needs to be considered in the FOV calculation.
4.a.2.a	System geometry – image position	1. The image position shall be checked relative to the FSTD centreline. 2. Where there is a design offset in the vertical display centre, this shall be stated.

4.a: Visual Scene Quality		Test requirements
4.a.2.b	System geometry – absolute geometry	1. The procedure for this test is to display a 5° grid to show the angular spacing. The initial assessment of the visual shall be performed by using a theodolite. The recurrent testing method may use a fixed grid projected from a slide or similar device. If the visual system image can be shown to align within the tolerances specified it may be assumed that the requirements are met based on the initial acceptance of the visual system. In the event there is any doubt about the test results or the visual system hardware parts have been modified, replaced or detached, then a theodolite measurement shall be used to demonstrate compliance. 2. Where a system with more than 200° x 40° is supplied, the geometry outside the central area shall not have any distracting discontinuities.
4.a.2.c	System geometry – relative geometry	1. For a diagram showing zones 1, 2 and 3 and further discussion of this test, see GM1 FSTD.QTG.A.400 para c) Image geometry. 2. Note: A means to perform this check with a simple go/no go gauge is encouraged for recurrent testing.
4.a.3	Surface resolution (object detection)	1. Resolution shall be demonstrated by a test of objects shown to occupy the required visual angle in each visual display used on a scene from the pilot's eye-point. 2. The object will subtend an angle no greater than the tolerance angle to the eye. 3. This may be demonstrated using threshold bars for a horizontal test. 4. A vertical test shall also be demonstrated. 5. The subtended angles shall be confirmed by calculations in an SOJ.
4.a.4	Lightpoint size	1. Light point size shall be measured using a test pattern consisting of a centrally located single row of white light points displayed as both a horizontal and vertical row. 2. It shall be possible to move the light points relative to the eyepoint in all axes. 3. At a point where modulation is just discernible in each visual channel, a calculation shall be made to determine the light spacing. 4. An SOJ is required to demonstrate the test method and calculation.
4.a.5	Raster surface contrast ratio	1. Surface contrast ratio shall be measured using a raster drawn test pattern filling the entire visual scene (all channels). 2. The test pattern shall consist of black and white squares, 5° per square with a white square in the centre of each channel. 3. Measurement shall be made on the centre bright square for each channel using a 1° spot photometer. This value shall have a minimum brightness of 7 cd/m2 (2ft-lamberts). Measure any adjacent dark squares.

4.a: Visual Scene Quality		Test requirements
		4. The contrast ratio is the bright square value divided by the dark square value. 5. Notes: a. During contrast ratio testing, FSTD aft-cab and flight deck ambient light levels shall be as low as possible. b. Measurements shall be taken at the centre of squares to avoid light spill into the measurement device.
4.a.6	Lightpoint contrast ratio	1. Lightpoint contrast ratio shall be measured using a test pattern demonstrating an area of greater than 1° filled with white lightpoints and shall be compared to the adjacent background. 2. Measurements of the background shall be taken such that the bright square is just out of the light metre FOV. 3. Notes: a. During contrast ratio testing, FSTD aft-cab and flight deck ambient light levels shall be as low as possible.
4.a.7	Light point brightness	1. Light points shall be displayed as a matrix creating a square. 2. Light points shall overlap such that the square is continuous (individual light points will not be visible).
4.a.8	Surface brightness	1. Surface brightness shall be measured on a white raster, measuring the brightness using the 1° spot photometer. 2. Lightpoints are not acceptable. 3. Use of calligraphic capabilities to enhance raster brightness is acceptable. 4. For raster only display devices the highlight brightness is measured using a white raster and measuring the average brightness in each channel.
4.a.9	Black level and sequential contrast	1. The light metre shall be mounted in a fixed position viewing the forward centre area of each display. 2. All projectors shall be turned off and the flight deck environment made as dark as possible. A background reading shall be taken of the remaining ambient light on the screen. 3. The projectors shall then be turned on and a black polygon displayed. A second reading shall then be taken and the difference between this and the ambient level recorded. 4. A full brightness white polygon shall then be measured for the sequential contrast test. 5. This test is generally only required for light valve projectors.
4.a.10	Motion blur	1. A test pattern consists of an array of 5 peak white squares with black gaps of decreasing width between them. 2. The range of black gap widths shall at least extend above and below the required detectable gap, and be in steps of 1 arc min. 3. The pattern is rotated at the required rate. 4. Two arrays of squares shall be provided, one rotating in heading and the other in pitch, to provide testing in both axes.

4.a: Visual Scene Quality		Test requirements
		5. A series of stationary numbers identifies the gap number. 6. Note: This test can be limited by the display technology. Where this is the case, the competent authority shall be consulted on the limitations. 7. This test is generally only required for light valve projectors.
4.a.11	Speckle test	1. An SOJ is required describing the test method. 2. This test is generally only required for laser projectors.

GM1 FSTD.QTG.A.400 Visual display system assessment - Aeroplane

This GM provides guidance for the assessment of visual display systems.

(a) Visual display system

(1) CS FSTD.QTG.A.400, tests 4.a.5 (Raster surface contrast ratio) and 4.a.6 (Lightpoint contrast ratio): This should be demonstrated using a raster-drawn test pattern filling the entire visual scene (three or more channels) consisting of a matrix of black and white squares no larger than five degrees per square with a white square in the centre of each channel. Measurement should be made on the centre bright square for each channel using a one degree spot photometer. Measure any adjacent dark squares. The surface contrast ratio is the bright square value divided by the dark square value. Lightpoint contrast ratio is measured when lightpoint modulation is just discernible compared to the adjacent background.

(2) CS FSTD.QTG.A.400, test 4.a.8 (Surface brightness): This should be demonstrated by maintaining the full test pattern described above, superimposing a highlight on the centre white square of each channel and measuring the brightness using the one degree spot photometer. Lightpoints are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable. See CS FSTD.QTG.A.400, test 4.a.8 (Surface brightness).

(3) CS FSTD.QTG.A.400, test 4.a.3 (Surface Resolution): Resolution should be demonstrated by a test of objects shown to occupy a visual angle of not greater than the specified value in arc minutes in the visual scene from the pilot's eyepoint. This should be confirmed by calculations in the SOJ.

(4) CS FSTD.QTG.A.400, test 4.a.4 (Lightpoint size): Lightpoint size should be measured in a test pattern consisting of a single row of lightpoints reduced in length until modulation is just discernible.

(b) Image geometry

The geometry of the final image as displayed to each pilot should meet the criteria defined. This assumes that the individual optical components have been tested to demonstrate a performance that is adequate to achieve this end result.

(1) CS FSTD.QTG.A.400, test 4.a.2.a.1 (Surface geometry - Image position)

(i) When measured from the pilot's and co-pilot's eyepoint, the centre of the image should be positioned horizontally between 0 degrees and 2 degrees inboard and within ±0.25 degree vertically relative to the FSTD centreline taking into account any designed vertical offset.

(ii) The differential between the measurements of horizontal position between each eyepoint should not exceed 1 degree.

Note: The tolerances are based on eye spacings of up to ±53.3 cm (±21 inch). Greater eye spacings should be accompanied by an explanation of any additional tolerance required.

(2) CS FSTD.QTG.A.400, test 4.a.2.a.2 (Surface geometry - absolute geometry)

The absolute geometry of any point on the image should not exceed 3 degrees from the theoretical position. This tolerance applies to the central 200 degrees by 40 degrees. For larger fields of view, there should be no distracting discontinuities outside this area.

(3) CS FSTD.QTG.A.400, test 4.a.2.a.3 (Surface geometry - relative geometry)

(i) The relative geometry check is intended to test the displayed image to demonstrate that there are no significant changes in image size over a small angle of view. With high-detail visual systems, the eye can be a very powerful comparator to discern changes in geometric size. If there are large changes in image magnification over a small area of the picture, the image can appear to 'swim' as it moves across the mirror.

(ii) The typical Mylar-based mirror system will naturally tend to form a 'bathtub' shape. This can cause magnification or 'rush' effects at the bottom and top of the image. These can be particularly distracting in the lower half of the mirror when in the final approach phase and hence should be minimised. The tolerances are designed to try to keep these effects to an acceptable level while accepting that the technology is limited in its ability to produce a perfect spherical shape.

(iii) The 200 degree x 40 degree FOV is divided up into three zones to set tolerances for relative geometry as shown in Figure 1.

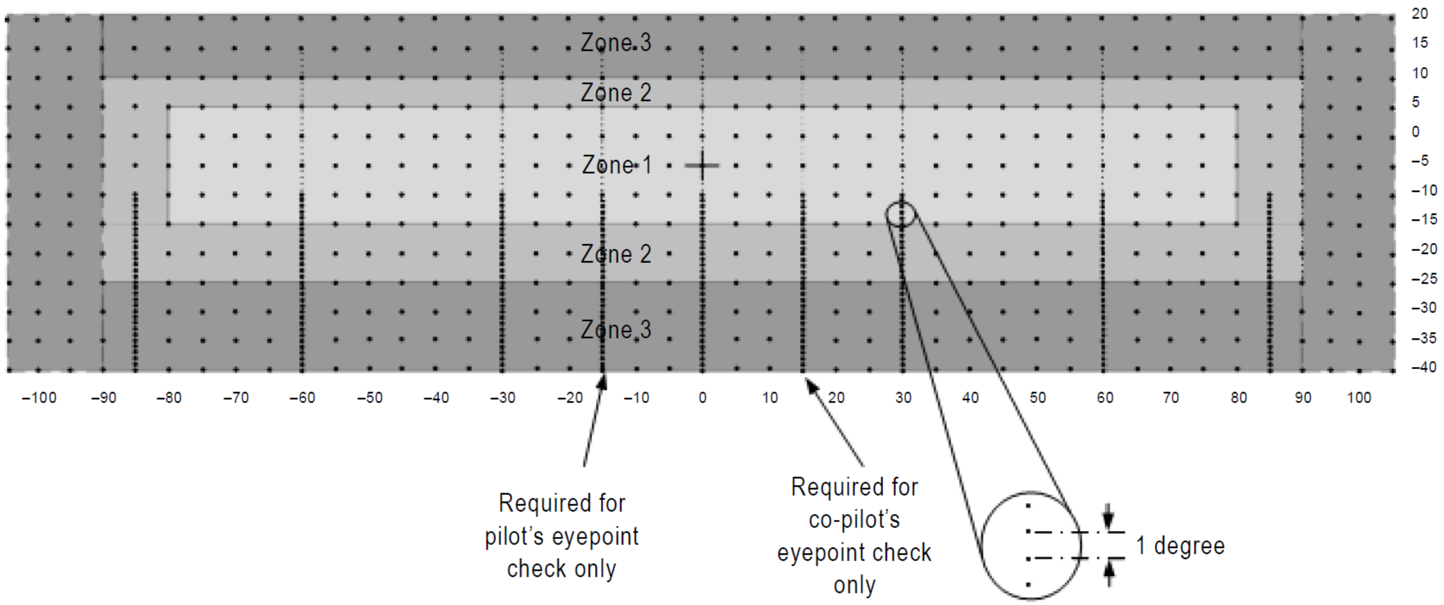

Figure 1. Relative geometry test pattern showing zones

(iv) Testing of the relative geometry should proceed as follows:

(A) from the pilot's eye position, measure every visible 5-degree point on the vertical lines and horizontal lines. Also, at -90, -60, -30, 0 and +15 degrees in azimuth, measure all visible 1-degree points from the -10° point to the lowest visible point;

Note: Not all points depicted on the pattern are measured, but they may be measured if observation suggests a problem.

(B) from the co-pilot's eye position, measure every visible 5 degree point on the vertical lines and horizontal lines. Also, at +90, +60, +30, 0 and -15 degrees in azimuth, measure all visible 1-degree points from the -10° point to the lowest visible point;

Note: Not all points depicted on the pattern are measured, but they may be measured if observation suggests a problem.

(C) the relative spacing of points should not exceed the following tolerances when comparing the gap between one pair of dots with the gap between an adjacent pair:

Zone 1 < 0.075 degree/degree;

Zone 2 < 0.15 degree/degree;

Zone 3 < 0.2 degree/degree;

(D) here, as 5-degree gaps are being measured, the tolerances should be multiplied by 5, e.g. one 5-degree gap should not be more than (5*0.075) = 0.375 degree more or less than the adjacent gap when in zone 1; and

(E) for larger fields of view, there should be no distracting discontinuities outside this area.

(v) For recurrent testing, the use of an optical checking device is encouraged. This device should typically consist of a handheld go/no go gauge to check that the relative positioning is maintained.

(c) Laser speckle contrast ratio (laser projection system)

The objective measure of speckle contrast that is described in the following subparagraphs considers the grainy structure of speckle and concentrates on the variations of brightness inherently introduced by speckle. Speckle contrast is quite commonly measured in many applications. However, speckle contrast does not take into account the size of the grains, i.e. the spatial wavelength of the speckle pattern.

(1) Definition of speckle contrast ratio

(i) Due to its noisy character, one adequate measure to quantify speckle is the root mean square (RMS) deviation derived from statistical theory: in a random distribution, the RMS deviation quantifies the amount of variation from the mean value.

(ii) When applied to the intensity profile of an illuminated surface, the speckle contrast C is the RMS deviation normalised to the mean value.

(iii) Given the intensity profile $I(x, y)$ in the considered field of view, the speckle contrast C can be defined as:

$$C = \frac{\sqrt{< I^2 > - < I >^2}}{< I >}$$

where the average operator < > operating on a profile $I(x, y)$ is defined as:

$$< I >= \frac{1}{A} \cdot \int_{FOV} I(x,y)dA$$

Hence:

$$C = \frac{\sqrt{A \cdot \int_{FOV} (I(x,y))^2 dA - \left(\int_{FOV} I(x,y)dA\right)^2}}{\int_{FOV} I(x,y)dA}$$

(2) Speckle measurement

(i) The intensity profile $I(x,y)$ can be measured with a charge-coupled device (CCD) camera. The set-up of the measurement (selection of lenses and CCD array) ensures that the granularity of the speckle can easily be resolved; hence, the granularity on the CCD chip should therefore be larger than the pixel size.

(ii) With the discrete nature of the CCD chip, $I(x,y)$ translates into an array $I_{m,n}$, while $\frac{1}{A} \cdot \int_{FOV} I(x,y)dA$ translates into $\frac{1}{m \cdot n} \cdot \sum_{FOV} I_{m,n}$

(iii) Therefore:

$$C = \frac{\sqrt{m \cdot n \cdot \sum_{FOV} I_{m,n}^2 - \left(\sum_{FOV} I_{m,n}\right)^2}}{\sum_{FOV} I_{m,n}}$$

where:

Symbol or Notation	Description	Units
Σ	Summation operator	N/A
A	Area	Arbitrary units
C	Speckle contrast	Per cent
FOV	Field of view	Degrees

I	Intensity	Arbitrary units
m	Number of pixel rows within FOV	N/A
n	Number of pixel columns within FOV	N/A

(iv) Since the definition of C is also sensitive to the profile's low-frequency variations across the FOV, either the illumination together with the reflectivity of the screen should be homogeneous, or the measured intensity profile should be corrected for these variations. This can be accomplished by applying a suitable high-pass filter; for example, by evaluating on sufficiently small FOVs in which low-frequency variations are negligible.

(v) To take into account the subjective nature of speckle, the f-number (or f# which is sometimes called the focal ratio expressing the diameter of the entrance pupil D divided by the focal length f, i.e. D/f) of the lens should be used as close as possible to that of the human eye. The recommended f# is 1/16.

(3) Speckle tolerance (see test 4.a.11)

If the speckle contrast is more than 10%, the image begins to appear disturbed. The distractive modulation as an overlay of the image reduces the perceptibility of the projected image and then degrades the perceived resolution. With a speckle contrast below 10%, the resolution and focus are not affected.

CS FSTD.QTG.A.405 Head-Up Display (HUD)

This CS provides standards for the objective tests of aeroplane Head-Up Display (HUD).

4.b: Head-Up Display (HUD)		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
4.b.1	Static alignment	N/A	Static alignment with displayed image	VIS		Init: ±6 arc min Rec: Same as Init	Init: ±6 arc min Rec: Same as Init
4.b.2	HUD attitude versus FSTD attitude indicator (pitch and roll of horizon)	Flight	pitch, and roll	VIS		Init: Pitch and roll align with aeroplane instruments Rec: EM	Init: Pitch and roll align with aeroplane instruments Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

4.b: Head-Up Display (HUD)		Test requirements
4.b.1	Static alignment	1. HUD boresight shall align with the centre of the displayed image spherical pattern. 2. For feature VIS with fidelity level S: The alignment requirement applies to any HUD system in use or both simultaneously if they can be used simultaneously for training. 3. For feature VIS with fidelity level R: The alignment requirement only applies to the pilot flying.
4.b.2	HUD attitude versus FSTD attitude indicator (pitch and roll of horizon)	1. For feature VIS with fidelity level R: The alignment requirement only applies to the pilot flying.

CS FSTD.QTG.A.410 Enhanced Flight Vision System (EFVS)

This CS provides standards for the objective tests of aeroplane Enhanced Flight Vision System (EFVS).

4.c: Enhanced Flight Vision System (EFVS)		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
4.c.1	Registration test	Take-off point and on approach at 61 m (200 ft)	Alignment between EFVS display and the window image	VIS		Init: Alignment shall represent the alignment typical of the aeroplane and system type Rec: Same as Init	Init: Alignment shall represent the alignment typical of the aeroplane and system type Rec: Same as Init
4.c.2	EFVS RVR and visibility calibration	Flight at 350 m (1200 ft) RVR and 1609 m (1 sm) RVR	EFVS view including correct light intensity	VIS		Init: The scene shall represent the EFVS view including correct light intensity Rec: Same as Init	Init: The scene shall represent the EFVS view including correct light intensity Rec: Same as Init
4.c.3	Thermal crossover	Day and night	Thermal crossover effects during day to night transition	VIS		Init: Demonstration of thermal crossover effects during day to night transition Rec: Same as Init	Init: Demonstration of thermal crossover effects during day to night transition Rec: Same as Init

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

4.c: Enhanced Flight Vision System (EFVS)		Test requirements
4.c.1	Registration test	1. Specific: The effects of the alignment tolerance in CS FSTD.QTG.A.405, test 4.b.1 (Static alignment) shall be taken into account 2. For feature VIS with fidelity level R: Alignment requirement only applies to the pilot flying.
4.c.2	EFVS RVR and visibility calibration	1. Infrared scene representative of both 350 m (1200 ft), and 1609 m (1 sm) RVR. 2. The visual scene may be removed.
4.c.3	Thermal crossover	1. The scene will correctly represent the thermal characteristics of the scene during a day to night transition.

CS FSTD.QTG.A.415 Night Vision Imaging System (NVIS)

This CS provides standards for the objective tests of aeroplane Night Vision Imaging System (NVIS).

4.d: Night Vision Imaging System (NVIS)		**Test Conditions**	**Tolerance Parameter**	**Primary Feature(s) Validated**	**Tolerances**		
					G	**R**	**S**
4.d.1	NVIS visible black level	Night, no moon, no stars, visual display configured for NVIS operation	Display brightness	VIS			Init: maximum 0.01 cd/m² (0.003 ft-lamberts) Rec: Same as Init
4.d.2	NVIS surface brightness	Visual display configured for NVIS operation	Brightness through NVIS	VIS			Init: minimum 3.4 cd/m² (1 ft-lamberts) Rec: Same as Init
4.d.3	NVIS surface contrast ratio	Visual display configured for NVIS operation	Contrast ratio through NVIS	VIS			Init: minimum 4:1 Rec: Same as Init
4.d.4	Lunar illumination	Night, full moon, visual display configured for NVIS operation	Display brightness	VIS			Init: 1 cd/m² ±0.025 (0.3 ft-lamberts ±0.007) Rec: EM
4.d.5	NVIS surface resolution	Night, full moon, visual display configured for NVIS operation	Surface resolution through NVIS	VIS			Init: better than 5 arc min Rec: EM

(a) Requirements for all the aeroplane Night Vision Imaging System tests:

4.d: Night Vision Imaging System (NVIS)	**Test requirements**
All tests	1. Applicable to actual NVIS only. 2. The visual / display system shall be configured for NVIS operation. 3. Where measures or observations through the NVIS are required, the automatic gain function of the imaging system shall be disabled (as applicable). 4. flight deck lights shall be turned off.

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

4.d: Night Vision Imaging System (NVIS)		**Test requirements**
4.d.1	NVIS visible black level	1. The scene shall be fully dark. The use of a black visual pattern on all channels is acceptable. 2. The measure is performed directly, without using the NVIS.
4.d.2	NVIS surface brightness	1. Use a similar pattern as for test CS FSTD.QTG.A.400, test 4.a.8 (Surface brightness). 2. The measure is performed directly, without using the NVIS.
4.d.3	NVIS surface contrast ratio	1. Use a similar pattern as for test CS FSTD.QTG.A.400, test 4.a.5 (Raster surface contrast ratio). 2. The measure is performed through the NVIS. 3. The gain of the NVIS shall be the same when measuring the white square and the black square.
4.d.4	Lunar illumination	1. Use a pattern that displays a unique white 5° square in the centre of the display, with black background. 2. The luminosity of the white square shall be the same as the luminosity of a full white lambertian surface under a full moon at 90° elevation, with a clear atmosphere. 3. The measure is performed directly, without using the NVIS.
4.d.5	NVIS surface resolution	1. Use a similar pattern as for CS FSTD.QTG.A.400, test 4.a.3 (Surface resolution). 2. The assessment is performed through the NVIS.

CS FSTD.QTG.A.420 Visual ground segment (VGS) - Aeroplane

This CS provides standards for the objective tests of aeroplane visual ground segment.

4.e: Visual Ground Segment		**Test Conditions**	**Tolerance Parameter**	**Primary Feature(s) Validated**	**Tolerances**		
					G	**R**	**S**
4.e.1	Visual ground segment (VGS)	Trimmed in the landing configuration at 30 m (100 ft) wheel height above touchdown zone on glide slope at a RVR setting of 300 m (1000 ft) or 350 m (1200 ft)	Near end: lights before threshold	VIS	Init: The correct number of approach lights within the computed VGS shall be visible Rec: Same as Init	Init: The correct number of approach lights within the computed VGS shall be visible Rec: Same as Init	Init: The correct number of approach lights within the computed VGS shall be visible Rec: Same as Init
			Far end: lights after the threshold	VIS	Init: ± 20% of the computed VGS Rec: as Init	Init: ± 20% of the computed VGS Rec: as Init	Init: ± 20% of the computed VGS Rec: as Init
			Threshold lights	VIS	Init: The threshold lights computed to be visible shall be visible Rec: as Init	Init: The threshold lights computed to be visible shall be visible Rec: as Init	Init: The threshold lights computed to be visible shall be visible Rec: as Init

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

4.e: Visual Ground Segment		**Test requirements**
4.e.1	Visual ground segment (VGS)	1. If non-homogenous fog is used, the vertical variation in horizontal visibility shall be described and be included in the slant range visibility calculation used in the VGS computation. 2. For feature FDK at fidelity level G: An appropriate cut-off angle characteristic of the class of aeroplane shall be used

4.e: Visual Ground Segment		Test requirements
		and any limits this may create on the number of lights visible shall be stated in the SOJ. Otherwise, a value of 15 degrees is acceptable.

GM1 FSTD.QTG.A.420 Visual ground segment - Aeroplane

This GM provides guidance for the assessment of the visual ground segment test.

(a) Visual ground segment

(1) This test is designed to assess items impacting the accuracy of the visual scene presented to a pilot at DH on an ILS approach. Those items include:

(i) RVR/visibility,

(ii) glideslope (G/S) and localiser modelling accuracy (location and slope) for an ILS,

(iii) for a given weight, configuration and speed representative of a point within the aeroplane's operational envelope for a normal approach and landing; and,

(iv) radio altimeter.

(2) Altitude and RVR for the assessment have been selected in order to produce a visual scene that can be readily assessed for accuracy (RVR calibration) and where spatial accuracy (centreline and glide slope) of the simulated aircraft can be readily determined using approach/runway lighting and flight deck instruments.

(3) The MQTG should indicate the source of data, i.e. airport and runway used, ILS G/S antenna location (airport and aircraft), pilot eye reference point, flight deck cut-off angle, etc., used to make accurate visual ground segment (VGS) scene content calculations. See figure 1.

(4) Automatic positioning of the simulated aircraft on the ILS is encouraged. If such positioning is accomplished, diligent care should be taken to ensure the correct spatial position and that aircraft attitude is achieved. Flying the approach manually or with an installed autopilot should also produce acceptable results.

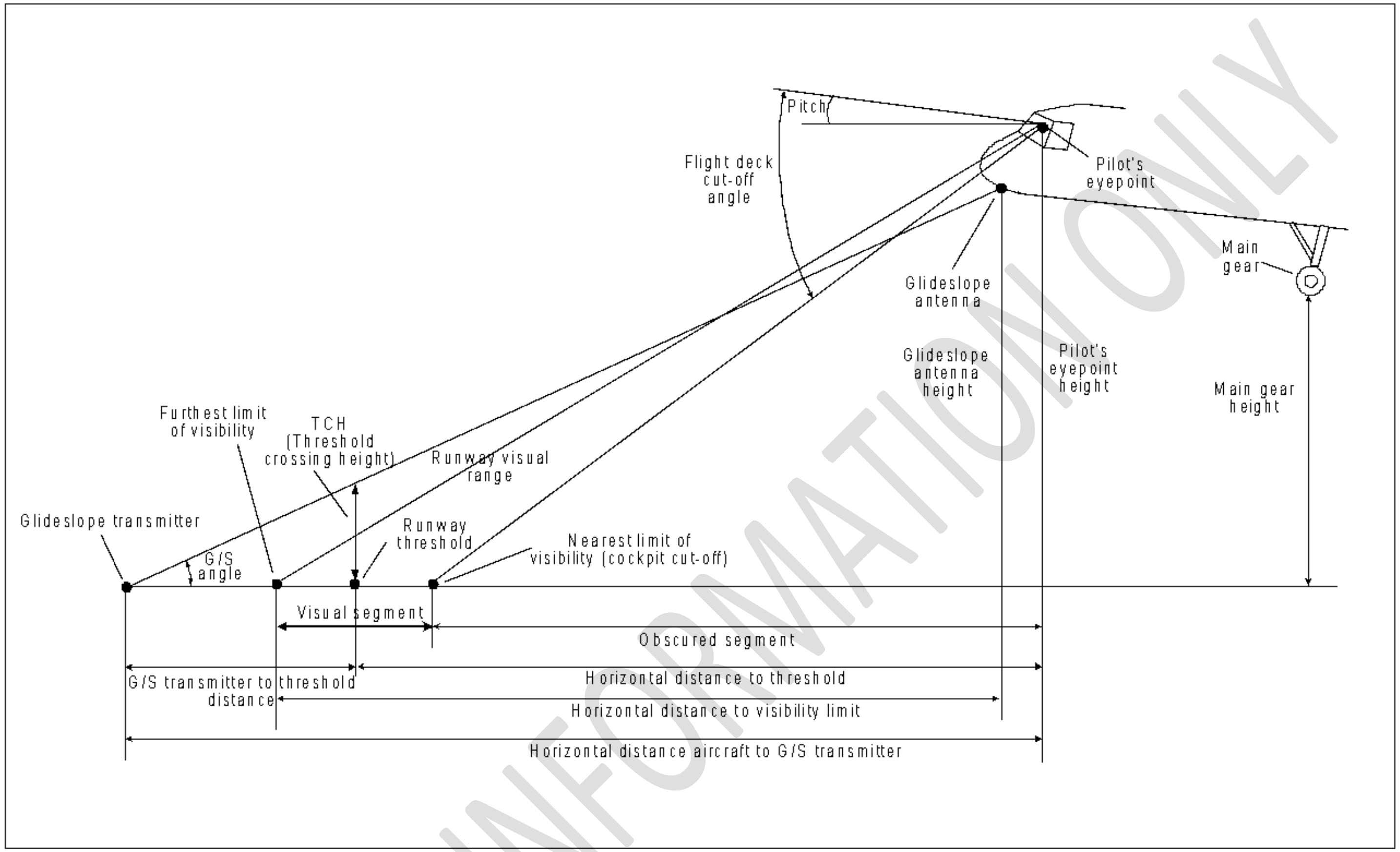

Figure 1. VGS scene content calculations

CS FSTD.QTG.A.500 Sound Systems - Aeroplanes

This CS provides standards for the objective tests of aeroplane Sound Systems.

5: Sound Systems		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
5.a: Turbo-jet / turbo-fan aeroplanes							
5.a.1	Ready for engine start	Ground	Sound amplitude	SND	Init: Subjective assessment of measured overall SPL Rec: ±3 dB SPL RMS compared to MQTG	Init: Subjective assessment of 1/3 octave bands Rec: Cannot exceed ±5 dB difference per 1/3 octave band compared to MQTG	Init: within ±5 dB per 1/3 octave band of the aeroplane data Rec: Same as Init
5.a.2	All engines at idle	Ground	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.a.3	All engines at maximum allowable thrust with brakes set	Ground	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.a.4	Climb	En-route climb	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.a.5	Cruise	Cruise	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.a.6	Speed brake/ spoilers extended (as appropriate)	Cruise	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1

5: Sound Systems		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
5.a.7	Initial approach	Approach	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.a.8	Final approach	Landing	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.b: Propeller aeroplanes							
5.b.1	Ready for engine start	Ground	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.b.2	All propellers feathered, if applicable	Ground	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.b.3	Ground idle or equivalent	Ground	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.b.4	Flight idle or equivalent	Ground	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.b.5	All engines at maximum allowable power with brakes set	Ground	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.b.6	Climb	En-route climb	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.b.7	Cruise	Cruise	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.b.8	Initial approach	Approach	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.b.9	Final approach	Landing	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1

5: Sound Systems		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
5.c-e: All Aeroplanes							
5.c	Special cases	As defined by applicant for FSTD qualification	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.d	FSTD background noise	N/A	Sound amplitude	SND	Init: subjective assessment of measured overall SPL. Rec: ±3 dB SPL RMS compared to MQTG	Init: each 1/3 octave band level shall be lower than the reference values in GM1 FSTD.QTG.A.500, figure 1 Rec: ±3 dB per 1/3 octave band compared to the MQTG	Init: each 1/3 octave band level shall be lower than the reference values in GM1 FSTD.QTG.A.500, figure 1 Rec: ±3 dB per 1/3 octave band compared to the MQTG
5.e	Frequency response	N/A	Sound amplitude	SND		Init: N/A Rec: cannot exceed ±5 dB on three consecutive bands when compared to the MQTG, and the average of the absolute differences between the MQTG	Init: N/A Rec: cannot exceed ±5 dB on three consecutive bands when compared to the MQTG, and the average of the absolute differences between the MQTG

<table>
<tr><th colspan="2" rowspan="2">5: Sound Systems</th><th rowspan="2">Test Conditions</th><th rowspan="2">Tolerance Parameter</th><th rowspan="2">Primary Feature(s) Validated</th><th colspan="3">Tolerances</th></tr>
<tr><th>G</th><th>R</th><th>S</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>and recurrent results cannot exceed 2 dB</td><td>and recurrent results cannot exceed 2 dB</td></tr>
</table>

(a) Requirements for all the aeroplane Sound Systems tests:

5: Sound Systems	Test requirements
All tests	1. For feature SND at fidelity level G: a. All tests in this section may be presented as a single overall SPL level and are only required when the flight deck is fully or partially enclosed (e.g. installed in a dedicated room). 2. For feature SND at fidelity levels R and S: a. All tests in this section shall be presented using an unweighted 1/3 octave band format from band 17 to 42 (50 Hz to 16 kHz). A minimum 20 s average shall be taken at the location corresponding to the reference data set. 3. For feature SND at fidelity level S: a. The validation data and FSTD results shall be produced using comparable data analysis techniques. It may be acceptable to have some 1/3 octave bands out of ± 5dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct. 4. The tests may give the test conditions and flight parameters as numerical snapshot values. 5. See GM1 FSTD.QTG.A.500.

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

<table>
<tr><th colspan="2">5: Sound Systems</th><th>Test requirements</th></tr>
<tr><td>5.a.1</td><td>Ready for engine start</td><td>1. Normal conditions prior to engine start. The auxiliary power unit (APU) shall be on if appropriate.</td></tr>
</table>

5: Sound Systems		Test requirements
5.a.2	All engines at idle	1. Normal conditions prior to take-off.
5.a.3	All engines at maximum allowable thrust with brakes set	1. Normal conditions prior to take-off. 2. The test is intended to check the maximum stabilised allowable thrust with brakes set, without jeopardising the aeroplane and safety.
5.a.4	Climb	1. Medium altitude.
5.a.5	Cruise	1. Normal cruise configuration.
5.a.6	Speed brake/ spoilers extended (as appropriate)	1. Normal and constant speed brake deflection for descent at a constant airspeed and power setting.
5.a.7	Initial approach	1. Constant airspeed, gear up, flaps/slats as appropriate.
5.a.8	Final approach	1. Constant airspeed, gear down, landing configuration flaps.
5.b.1	Ready for engine start	1. Normal conditions prior to engine start. The APU shall be on if appropriate.
5.b.2	All propellers feathered, if applicable	1. Normal conditions prior to take-off.
5.b.3	Ground idle or equivalent	1. Normal conditions prior to take-off.
5.b.4	Flight idle or equivalent	1. Normal conditions prior to take-off.
5.b.5	All engines at maximum allowable power with brakes set	1. Normal conditions prior to take-off.

5: Sound Systems		Test requirements
5.b.6	Climb	1. Medium altitude.
5.b.7	Cruise	1. Normal cruise configuration.
5.b.8	Initial approach	1. Constant airspeed, gear up, flaps extended as appropriate, RPM as per operations manual.
5.b.9	Final approach	1. Constant airspeed, gear down, landing configuration flaps, RPM as per operations manual.
5.c	Special cases	1. Special steady-state cases identified as particularly significant to the pilot, important in training, or unique to a particular aeroplane type or model. 2. See GM1 FSTD.QTG.A.500.
5.d	FSTD background noise	1. The simulated sound will be evaluated to ensure that the background noise does not interfere with training. 2. See GM1 FSTD.QTG.A.500, para e. 3. The measurements shall be made with the simulation running, the sound muted and a dead flight deck.
5.e	Frequency response	1. The test shall be run at three frequencies (high, mid-range, and low). 2. See GM1 FSTD.QTG.A.500, para g.

GM1 FSTD.QTG.A.500 Sound system assessment

This GM provides guidance for the assessment of sound systems.

(a) General

The total sound environment in the aircraft is very complex, and changes with atmospheric conditions, aircraft configuration, airspeed, altitude, power settings, etc. Thus, flight deck sounds are an important component of the flight deck operational environment and as such provide valuable information to the flight crew. These aural cues can either assist the crew, as an indication of an abnormal situation, or hinder the crew, as a distraction or nuisance. For effective training, the FSTD should provide flight deck sounds that are perceptible to the pilot during normal and abnormal operations, and that are comparable to those of the aircraft. Accordingly, the organisation requesting qualification of an FSTD should carefully evaluate background noises in the location being considered. To demonstrate compliance with the sound requirements, the objectives or validation tests have been selected to provide a representative sample of normal static conditions typical of those experienced by a pilot.

(b) Alternate engine fits

For FSTDs with multiple propulsion configurations, any condition listed in the table of FTSD validation tests versus feature fidelity levels in CS FSTD.QTG.A (all paragraphs) or CS FSTD.QTG.H (all paragraphs) that is identified by the data provider as significantly different due to a change in engine model, should be presented for evaluation as part of the QTG.

(c) Data and data collection system

(1) Information provided to the FSTD manufacturer should comply with the document entitled 'Flight Simulation Training Device Design & Performance Data Requirements, ARINC 450' as amended. This information should contain calibration and frequency response data.

(2) The system used to perform the tests listed in CS FSTD.QTG.A.500 should comply with the following standards:

(i) For feature SND with fidelity levels R and S (1/3 octave measurements):

(A) ANSI S1.11 - 1986 - Specification for octave, half octave and third octave band filter sets; and

(B) IEC 1094-4 - 1995 - measurement microphones - type WS2 or better.

(ii) For feature SND with fidelity level G (overall SPL measurements):

IEC 61672, IEC 60651, or ANSI S1.4 - Sound level meters, time-weighting, class/type 2 or better. Equipment not meeting the IEC or ANSI standards, such as a smartphone with a 'decibel meter' application or a computer with an external microphone, may be acceptable provided they can achieve repeatable measurements within the validation test tolerances.

(d) Headsets

If headsets are used during normal operation of the aircraft, they should also be used during the FSTD evaluation.

(e) Background noise

(1) Background noise is the noise in the FSTD due to the FSTD's cooling and hydraulic systems that is not associated with the aircraft, and the extraneous noise from other locations in the building. Background noise can seriously impact the correct simulation of aircraft sounds, so the goal should be to keep the background noise below the aircraft sounds. In some cases, the sound level of the simulation can be increased to compensate for the background noise. However, this approach is limited by the specified tolerances and by the subjective acceptability of the sound environment to the evaluation pilot.

(2) The acceptability of the background noise levels is dependent upon the normal sound levels in the aircraft or class of aircraft being represented. Background noise levels that fall below the lines defined by the following points, may be acceptable (refer to figure 1 below):

(i) 70 dB at 50 Hz;

(ii) 55 dB at 1 000 Hz;

(iii) 30 dB at 16 kHz.

These limits are for unweighted 1/3 octave band sound levels. Meeting these limits for background noise does not ensure an acceptable FSTD. Aeroplane sounds which fall below this limit require careful review and may require lower limits on the background noise.

(f) MQTG and recurrent evaluations

If recurrent frequency response and FSTD background noise results are within tolerance, respective to the MQTG, and the operator can prove that no software or hardware changes have occurred that will affect the aircraft cases, then it is not required to rerun those cases during recurrent evaluations.

If the test defined in CS FSTD.QTG.A.500, 5.a or 5.b, and CS FSTD.QTG.H.500, 5.a are rerun during recurrent evaluations, then the results may be compared against initial evaluation results rather than aircraft master data.

(g) Validation testing

Deficiencies in aircraft recordings should be considered when applying the specified tolerances to ensure that the simulation is representative of the aircraft. Examples of typical deficiencies are:

(1) variation of data between tail numbers;

(2) frequency response of microphones;

(3) repeatability of the measurements; and

(4) extraneous sounds during recordings.

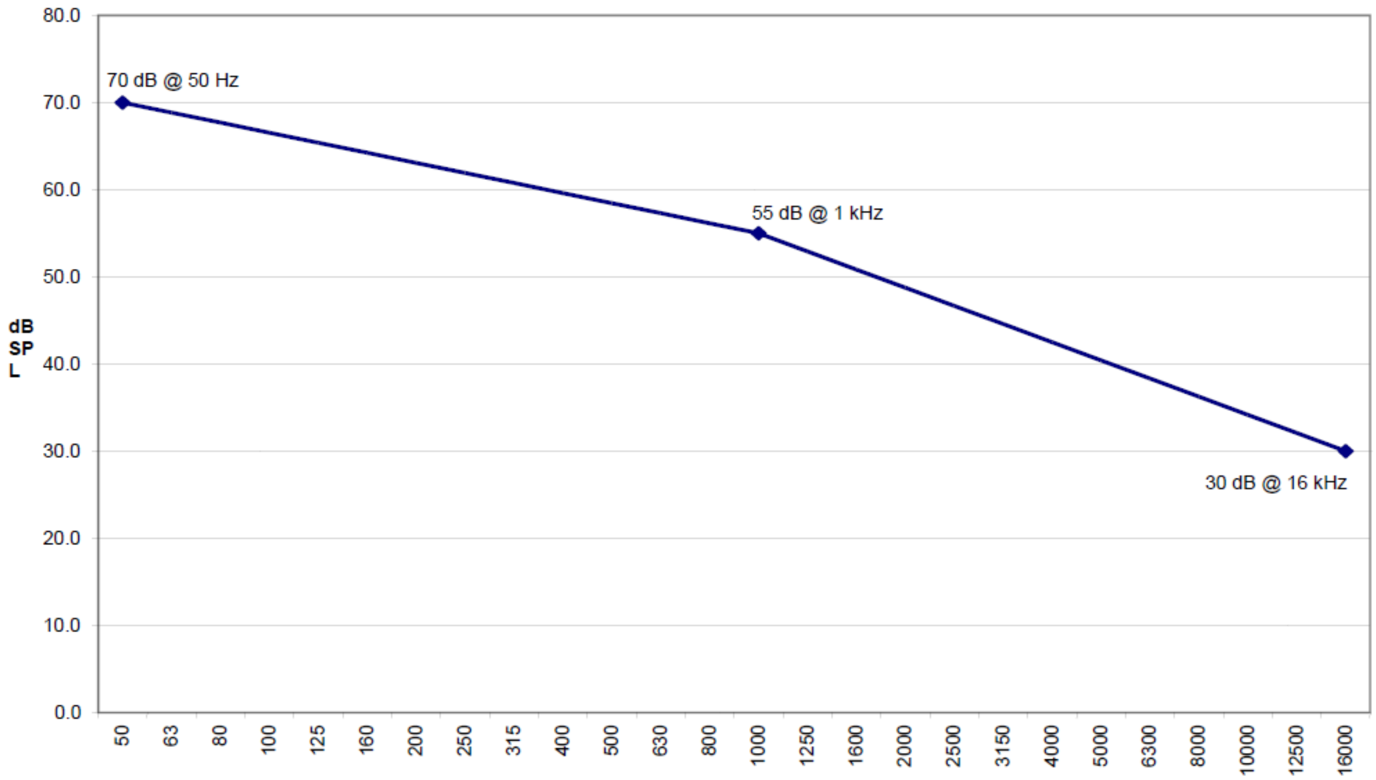

Figure 1. 1/3-octave band frequency (Hz)

Table 1. Example of recurrent frequency response test tolerance

Band Centre Freq.	Initial Results (dBSPL)	Recurrent Results (dBSPL)	Absolute Difference
50	75.0	73.8	1.2
63	75.9	75.6	0.3
80	77.1	76.5	0.6
100	78.0	78.3	0.3
125	81.9	81.3	0.6
160	79.8	80.1	0.3
200	83.1	84.9	1.8
250	78.6	78.9	0.3
315	79.5	78.3	1.2
400	80.1	79.5	0.6
500	80.7	79.8	0.9
630	81.9	80.4	1.5
800	73.2	74.1	0.9
1000	79.2	80.1	0.9
1250	80.7	82.8	2.1
1600	81.6	78.6	3.0
2000	76.2	74.4	1.8
2500	79.5	80.7	1.2
3150	80.1	77.1	3.0
4000	78.9	78.6	0.3
5000	80.1	77.1	3.0
6300	80.7	80.4	0.3
8000	84.3	85.5	1.2
10000	81.3	79.8	1.5
12500	80.7	80.1	0.6
16000	71.1	71.1	0.0
		Average	1.1

CS FSTD.QTG.A.600 Systems Integration

This CS provides standards for the objective tests of aeroplane systems integration.

6.a: Systems Integration - Systems Response Time		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
6.a.1	System response time - transport delay	Pitch, roll, and yaw	Motion system response time	MTN		Init: 100 ms or less after controller movement Rec: Same as Init	Init: 100 ms or less after controller movement Rec: Same as Init
			Instruments system response time	SYS	Init: 200 ms or less after controller movement Rec: Same as Init	Init: 200 ms or less after controller movement Rec: EM	Init: 100 ms or less after controller movement Rec: Same as Init
			Visual system response time	VIS	Init: 200 ms or less after controller movement Rec: Same as Init	Init: 200 ms or less after controller movement Rec: Same as Init	Init: 120 ms or less after controller movement Rec: Same as Init

(a) Requirements for all the aeroplane systems integration tests:

6.a: Systems Integration - Systems Response Time	Test requirements
All tests	1. The test to determine compliance with these requirements shall include simultaneously recording the output from the pilot's pitch, roll and yaw controllers, the output from the accelerometer attached to the motion system platform located at an acceptable location near the pilots' seats, the output signal to the visual system display (including visual system analogue delays) and the output signal to the pilot's attitude indicator or an equivalent test approved by the competent authority.

6.a: Systems Integration - Systems Response Time	Test requirements
	2. Tolerances are based upon the requirement to support the highest device type employing that fidelity level.

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

6.a: Systems Integration - Systems Response Time	Test requirements
All tests	1. The tests to determine compliance with these requirements shall include simultaneously recording the output from the pilot's pitch, roll and yaw controllers, the output from the accelerometer attached to the motion system platform located at an acceptable location near the pilots' seats, the output signal to the visual system display (including visual system analogue delays) and the output signal to the pilot's attitude indicator or an equivalent test approved by the competent authority. 2. A separate test is required for each test condition. 3. For feature MTN at fidelity levels R and S: a. Motion onset shall also occur within the system dynamic response limit of 100 ms. While motion onset shall occur before the start of the scan of the first video field containing different information, it must occur before the end of the scan of the same video field. 4. Visual scene changes from steady state disturbance (i.e. the start of the scan of the first video field containing different information) shall occur within the defined tolerance. 5. Where EFVS/HUD systems are installed, even when software is simulated, the EFVS/HUD response shall be within ± 30 ms from visual system response, and not before motion system response. 6. The delay from the aeroplane EFVS electronic elements shall be added to the 3 0ms tolerance before comparison with visual system reference as described in GM1 FSTD.QTG.A.600. 7. See GM1 FSTD.QTG.A.600.

GM1 FSTD.QTG.A.600 Transport delay testing methods - Aeroplanes

This GM provides guidance for the assessment of the for transport delay tests.

(a) Background

(1) The purpose of this CS is to provide the methods for conducting transport delay tests.

(2) The transport delay test is the primary method for determining the delay introduced into the FSTD due to the time taken for the computations through the FSTD controls, host, motion and visual computer modules. The transport delay test is not dependent upon flight test data but may require avionics computer and instrument data from the data provider for some cases described below. Figure 1 presents the principles of transport delay testing.

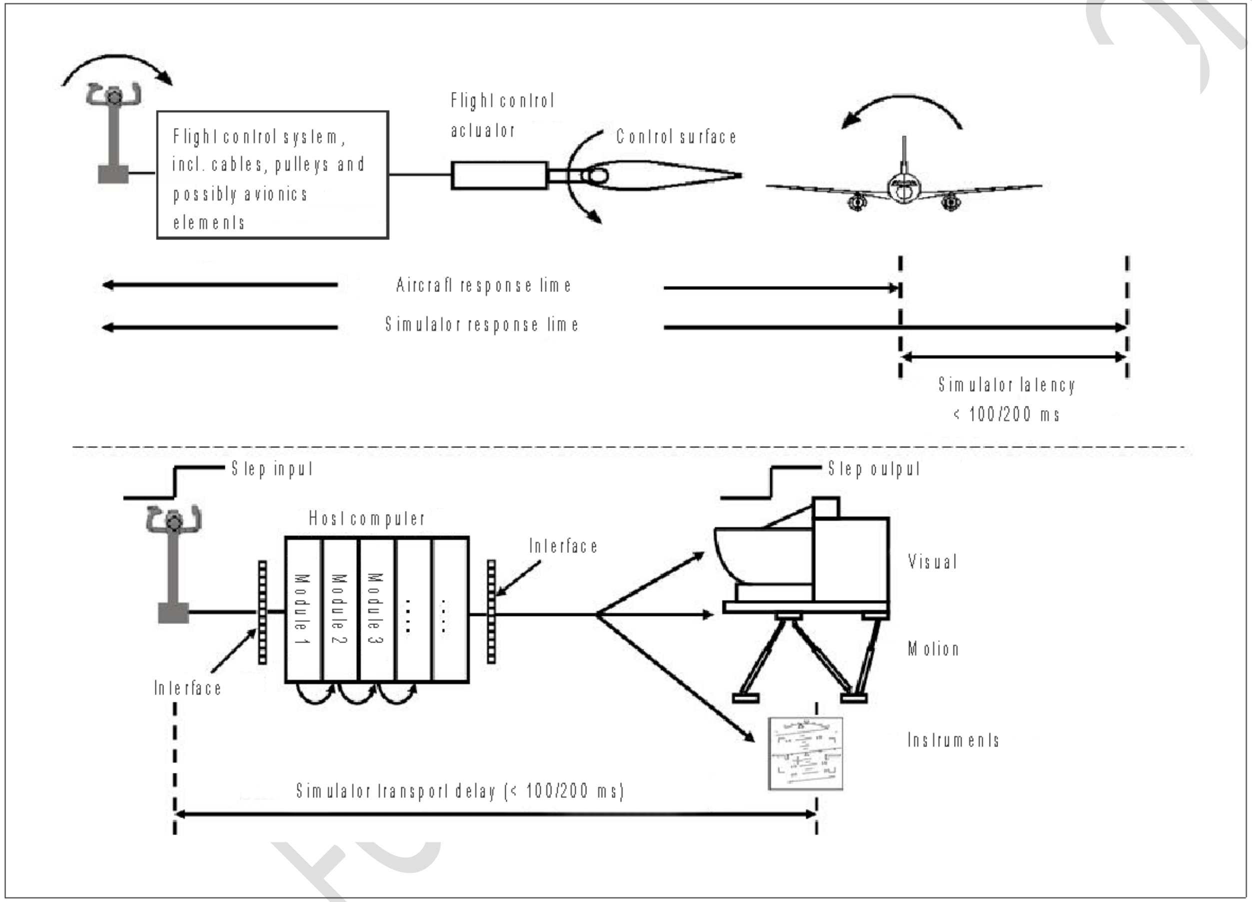

Figure 1. Transport delay and latency testing

(b) Transport delay

(1) The purpose of this paragraph (b) is to demonstrate how to determine the introduced transport delay through the FSTD system such that it does not exceed a specific duration. It is not the intention of the transport delay test to arrive at a comparison with the aircraft but rather to demonstrate acceptable performance of the simulation at initial qualification, and then to be used as a non-regression test for the software architecture at each recurrent evaluation. The transport delay needs to be measured from control inputs through the interface, through each of the host computer modules and back through the interface to motion, flight instrument and visual systems, and shown to be no more than the tolerances required in the validation test tables.

(2) In all cases, the simulation will have been demonstrated to be dynamically equivalent to the aircraft or class of aircraft in terms of response by the many dynamic tests in the QTG as well as the subjective handling tests, both for short-term and long-term modes. It is, therefore, only necessary to measure the maximum increased time added by the various interfaces and computing elements in the FSTD that are not present in the aircraft. To do this, a signal is processed through the entire system from the input to the first interface from the control column or stick, through each subsequent computing element or interface and back out to the physical feedback to the pilot, via the motion system, visual system or flight deck instruments. To make this signal more traceable, a handshaking method may be used from element to element such that a clear leading edge is visible at any point through the system. However, it should be noted that the signal needs to be passed through each element of the software and hardware architectures and that the simulation should be running in its normal mode with all software elements active. This is to ensure that the test may be rerun at subsequent re-qualifications to check that software modifications have not modified the overall path length. A full description of the method chosen and the path of the signal, as well as the input and recording points, should be provided.

(3) The test result analysis requires only that the input and output signals be measured to be separated by no more than the limits of the toleranced parameters, according to the FCS of the FSTD. The point of movement will be very simple to determine since both input and output signals will have clear leading edges.

(4) Figure 2 illustrates the total transport delay for a non-computer-controlled aircraft. Since there are no aircraft-induced delays for this case, the total transport delay is equivalent to the introduced delay.

(5) Computer-controlled aircraft

For FSTDs of aircraft with electronic elements in the path between input from the pilot and resulting output, the measured transport delay will include elements of the aircraft itself. These may include flight control systems, avionics or display systems. Since the intention of the transport delay test is to measure only the time specific to the FSTD and not that of the aircraft, the test result time should be offset by the throughput time of the avionics elements. This throughput time should be based on data from the manufacturer of the aircraft or avionics. Alternatively, the aircraft equipment may be bypassed, provided that the signal path is maintained in terms of FSTD interfaces. A schematic diagram should be provided to present that part of the aircraft equipment being considered in this manner, and the way in which the signal path has been treated to be representative of all the simulation elements (see Figure 3).

(i) For FSTDs on which the avionics elements in question are replaced by re-hosted, re-targeted or other similar solutions, it is still necessary to offset the test result by the equivalent time of the aircraft elements. However, the schematic diagram should in this case demonstrate the equivalence of the simulated avionics to the real avionics in terms of architecture. It is the responsibility of the developer of the re-hosted, re-targeted, or other similar solution to establish the equivalence of the simulated element to the aircraft element being replaced.

(ii) For cases of computer-controlled aircraft, where it can be established that the data path to the instrumentation in the aircraft is subject to computer and data bus asynchronism, uncertainty or 'jitter' of a similar order of magnitude to the transport delay allowance, an SOJ will suffice in place of an actual test. This SOJ should establish the equivalence of the simulated solution to that of the aircraft and provide a rationale regarding the statistical uncertainty. In this case, the need for the objective tests 6.a.1 for pitch, roll and yaw may be waived.

(6) Recorded signals

The signals recorded to conduct the transport delay calculations should be explained on a schematic block diagram. The FSTD manufacturer should also provide an explanation of why each signal was selected and how they relate to the above descriptions.

(7) Interpretation of results

It is normal that FSTD results vary over time from test to test. This can easily be explained by a simple factor called 'sampling uncertainty'. FSTDs may run at a specific rate where all modules are executed sequentially in the host computer. The flight controls input can occur at any time in the iteration, but this data will not be processed before the start of the new iteration. For an FSTD running at 60 Hz, a worst-case difference of 16.67 ms can be expected. Where multiple parallel processors or priority-based execution systems are used, the scatter may be greater. Moreover, in some conditions, the host computer and the visual system do not run at the same iteration rate, therefore the output of the host computer to the visual will not always be synchronised.

(8) When offsetting the measured results by the throughput time of the avionics elements, it is also necessary to recognise that digital equipment will normally give a range of response times dependent upon the synchronisation of the control input with the internal equipment frame time. The aircraft or avionics manufacturer should quantify the range of results that should be expected by providing minimum and maximum

response times, as well as an indication of the statistical spread in this range. It may be necessary to run the test several times on the FSTD to demonstrate the correctness of the avionics simulation in these conditions.

(9) The transport delay test should account for daylight, twilight (dusk, dawn) and night modes (as applicable) of operation of the visual system. The tolerance is as required in the validation test tables and motion response should occur before the end of the first video scan containing new information. Where it can be demonstrated that the visual system operates at the same execution rate for both day and night modes, a single test in each axis is sufficient.

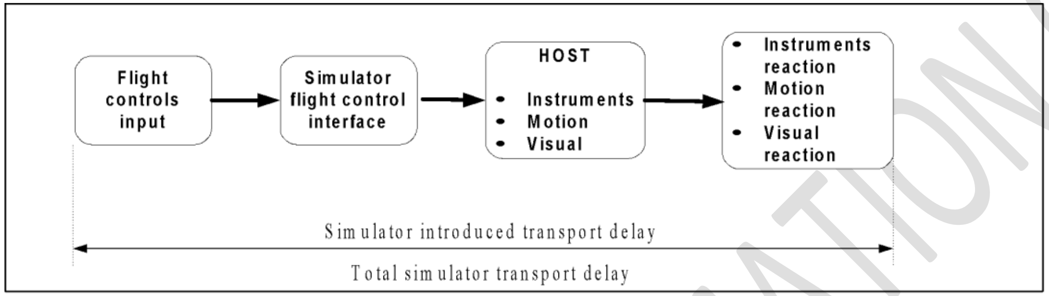

Figure 2. Transport delay for simulation of a classic non-computer-controlled aircraft

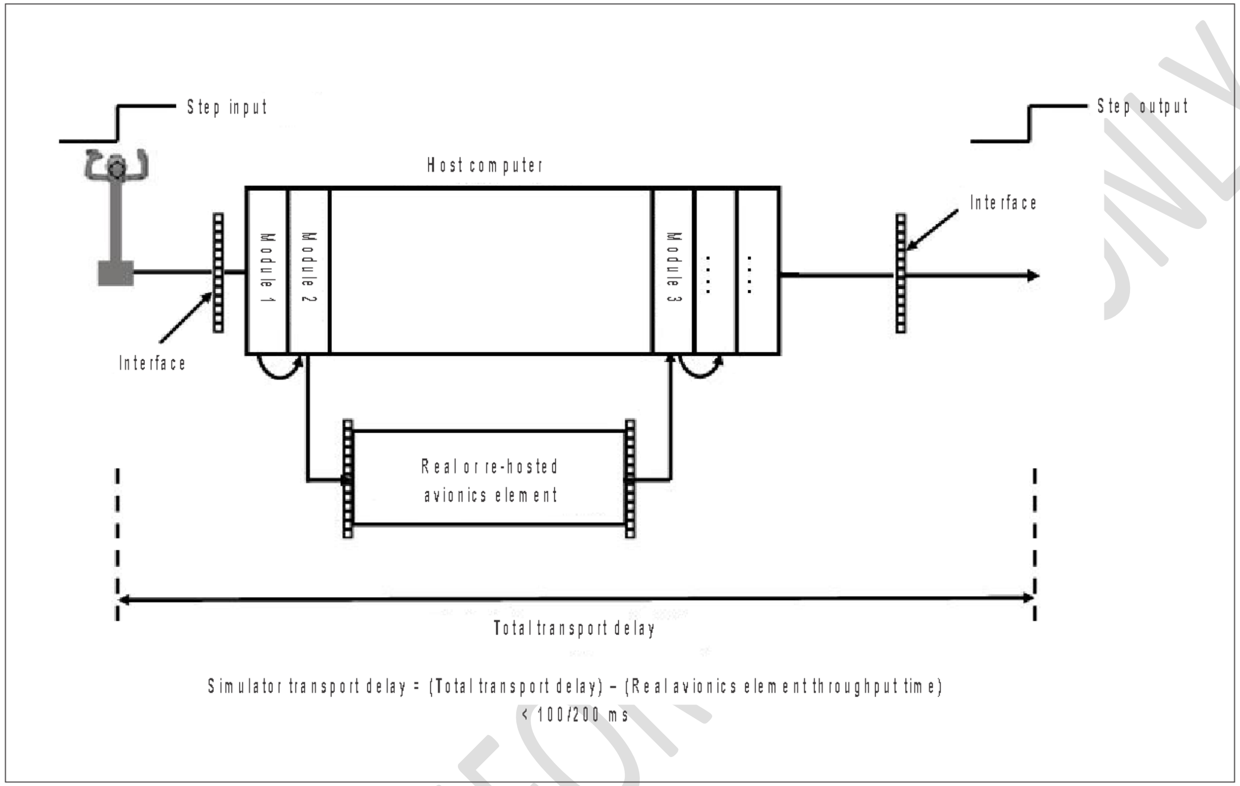

Figure 3. Transport delay with avionics elements

OBJECTIVE TESTS FOR ROTORCRAFT

CS FSTD.QTG.H.100 Performance - Engine assessment - Rotorcraft

This CS provides standards for the objective tests of rotorcraft performances for engine assessment.

1.a: Performance - Engine Assessment		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.a.1.a	Start operations - Engine start and acceleration (transient)	Ground Rotor brake used, and not used	Light off time	SYS	Init: CT&M Rec: EM	Init: ±10% or ±1 s Rec: EM	Init: ±10% or ±1 s Rec: EM
			Torque	GND		Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Rotor speed	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3% Rec: EM
			Gas generator speed	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Power turbine speed	GND		Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Turbine gas temp.	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±30°C Rec: EM
1.a.1.b	Steady state idle and operating RPM conditions	Ground	Torque	GND	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Rotor speed	GND	Init: CT&M Rec: EM	Init: ±1.5% Rec: EM	Init: ±1.5% Rec: EM
			Fuel flow	GND			Init: ±5% Rec: EM

1.a: Performance - Engine Assessment		**Test Conditions**	**Tolerance Parameter**	**Primary Feature(s) Validated**	**Tolerances**		
					G	**R**	**S**
			Gas generator speed	GND			Init: ±2% Rec: EM
			Power turbine speed	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2% Rec: EM
			Turbine gas temp.	GND			Init: ±20°C Rec: EM
1.a.2	Power turbine speed trim	Ground Actuation of trim system in both directions	Total change of power turbine speed	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Or				
			Rotor speed	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±0.5% Rec: EM
1.a.3	Engine and rotor speed governing	Climb and descent	Torque	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Rotor speed	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5% Rec: EM

(a) Individual Test Requirements: the individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.a: Performance - Engine Assessment		**Test requirements**
1.a.1.a	Start operations - Engine start and acceleration	1. Time histories of each engine from initiation of start sequence to steady state idle and from steady state idle to operating RPM according to recommended RFM procedure (i.e. through steady state idle or directly to operating RPM according to RFM).

1.a: Performance - Engine Assessment		Test requirements
	(transient)	2. Tolerance to be only applied in the validity domain of the engine parameter sensors. 3. Light off time shall be defined according to required checks in approved RFM normal engine start procedure, e.g. a. starter disengaged before a NG value stated in RFM, b. or main rotor starts spinning before a NG value stated in RFM, c. or according to a particular RFM procedure.
1.a.1.b	Steady state idle and operating RPM conditions	1. Present data for both steady state idle and operating RPM conditions. 2. May be a series of snapshot tests.
1.a.2	Power turbine speed trim	1. Time history of engine response to trim system actuation. 2. Both directions shall have to be demonstrated.
1.a.3	Engine and rotor speed governing	1. Collective step inputs. 2. Can be conducted with climb and descent performance tests. 3. Collective up input shall be performed while rotorcraft is initially in descent. Large input is recommended, so that rotorcraft is no more in descent after control input and significant torque variation is obtained. 4. Collective down input shall be performed while rotorcraft is initially in climb. Large input is recommended, so that rotorcraft is no more in climb after control input and significant torque variation is obtained.

CS FSTD.QTG.H.105 Ground operations - Rotorcraft

This CS provides standards for the objective tests of rotorcraft performances for ground operations.

1.b: Ground Operations		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.b.1	Reserved						
1.b.2	Rate of turn vs pedal deflection or steering wheel angle	Ground Left and right turns	Turn rate	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% or ±2°/s Rec: EM
1.b.3	Taxi	Ground	Pitch angle	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			Torque	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3% Rec: EM
			Longitudinal control position	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Lateral control position	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Directional control position	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Collective control position	GND	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
1.b.4	Brake effectiveness	Ground	Time	GND			Init: CT&M Rec: ±10% or ±1 s

1.b: Ground Operations		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Distance	GND			Init: CT&M Rec: ±10% or ±5 m (15 ft)

(a) Individual Test Requirements: the individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.b: Ground Operations		Test requirements
1.b.2	Rate of turn vs pedal deflection or steering wheel angle	1. Without usage of wheel brakes 2. Left and right turns must be demonstrated.
1.b.4	Brake effectiveness	1. Record data until full stop.

CS FSTD.QTG.H.110 Take-off - Rotorcraft

This CS provides standards for the objective tests of rotorcraft performances for take-off.

1.c: Take-off		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.c.1	All engines	Take-off from IGE hover and initial climb	Airspeed	IGE	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Altitude	IGE	Init: CT&M Rec: EM	Init: ±20 ft (6.1 m) Rec: EM	Init: ±20 ft (6.1 m) Rec: EM
			Torque	IGE	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Rotor speed	IGE	Init: CT&M Rec: EM	Init: ±1.5% Rec: EM	Init: ±1.5% Rec: EM
			Pitch angle	IGE	Init: CT&M Rec: EM	Init: ±2.5° Rec: EM	Init: ±1.5° Rec: EM
			Bank angle	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Heading	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Lateral control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Directional control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM

1.c: Take-off		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Collective control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
1.c.2	OEI continued take-off	Take-off from IGE hover and initial climb	Airspeed	IGE	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Altitude	IGE	Init: CT&M Rec: EM	Init: ±20 ft (6.1 m) Rec: EM	Init: ±20 ft (6.1 m) Rec: EM
			Torque	IGE	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Rotor speed	IGE	Init: CT&M Rec: EM	Init: ±1.5% Rec: EM	Init: ±1.5% Rec: EM
			Pitch angle	IGE	Init: CT&M Rec: EM	Init: ±2.5° Rec: EM	Init: ±1.5° Rec: EM
			Bank angle	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Heading	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Lateral control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Directional control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM

1.c: Take-off		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
			Collective control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
1.c.3	OEI rejected take-off	Take-off from IGE hover	Airspeed	IGE	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Altitude	IGE	Init: CT&M Rec: EM	Init: ±20 ft (6.1 m) Rec: EM	Init: ±20 ft (6.1 m) Rec: EM
			Torque	IGE	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Rotor speed	IGE	Init: CT&M Rec: EM	Init: ±1.5% Rec: EM	Init: ±1.5% Rec: EM
			Pitch angle	IGE	Init: CT&M Rec: EM	Init: ±2.5° Rec: EM	Init: ±1.5° Rec: EM
			Bank angle	IGE	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM	Init: ±1.5° Rec: EM
			Heading	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Lateral control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Directional control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM

1.c: Take-off		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Collective control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Distance	IGE	Init: CT&M Rec: EM	Init: ±7.5% or 30 m (100 ft) Rec: EM	Init: ±7.5% or 30 m (100 ft) Rec: EM
1.c.4	Lift-off to hover	Ground	Torque	IGE	Init: CT&M Rec: EM	Init: ±5% Rec: EM	Init: ±5% Rec: EM
			Pitch angle	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Bank angle	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Heading	IGE	Init: CT&M Rec: EM	Init: ±3° Rec: EM	Init: ±3° Rec: EM
			Longitudinal control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Lateral control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Directional control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Collective control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM

(a) Requirements for all the rotorcraft take-off tests:

1.c: Take-off	Test requirements
All tests	1. Wind conditions shall be justified. In addition, if wind is not constant during the test, it shall be plotted. 2. For fidelity level G only, a FSTD footprint validated by an instructor is an acceptable alternative to CT&M for initial evaluation.

(b) Individual Test Requirements: the individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.c: Take-off		Test requirements
1.c.1	All engines	1. Time history of take-off from hover. 2. When airspeed is not valid or not reliable, tolerance shall be applied to groundspeed instead. 3. Record data to at least 200 ft (61 m) above terrain elevation/V_Y whichever comes later. 4. Initial pressure-altitude may not be reliable due to rotor downwash; in such case, height above ground shall be used instead for defining initial conditions and pressure-altitude shall be assessed once it is reliable. As an alternative, GNSS altitude above ellipsoid can be used (with initial offset compensated) instead of pressure-altitude during the whole test.
1.c.2	OEI continued take-off	1. Time history of open field CAT A take-off from hover, with one engine failure after TDP. 2. When airspeed is not valid or not reliable, tolerance shall be applied to groundspeed instead. 3. Record data to at least 200 ft (61 m) above terrain elevation/V_Y whichever comes later. 4. Initial pressure-altitude may not be reliable due to rotor downwash; in such case, height above ground shall be used instead for defining initial conditions and pressure-altitude shall be assessed once it is reliable. As an alternative, GNSS altitude above ellipsoid can be used (with initial offset compensated) instead of pressure-altitude during the whole test. 5. Use of OEI training mode is acceptable.
1.c.3	OEI rejected take-off	1. Time history of open field take-off from hover, with one engine failure before TDP, until touch down. 2. Test conditions near limiting performance as per aircraft manual. 3. When airspeed is not valid or not reliable, tolerance shall be applied to ground speed instead. 4. Pressure-altitude may not be reliable due to rotor downwash; either height above ground or GNSS altitude shall be used instead.

1.c: Take-off		**Test requirements**
		5. Use of OEI training mode is acceptable.
1.c.4	Lift-off to hover	1. Record a manoeuvre starting on ground with collective full down till stabilised in hover IGE.

GM1 FSTD.QTG.H.110 Take-off - Rotorcraft

The wind conditions (speed and direction) are generally available from windsock, control tower or ATIS. However, wind can sometimes change rapidly, for instance it is common to encounter a wind gradient function of the height above ground due to the friction forces close to the surface of the Earth. In such cases, replaying the reference flight data with the static wind conditions maintained constant during the test may not be suitable and the wind gradient should be estimated and set during the test.

The actual wind at the ownship position can often be estimated by comparing airspeed components with groundspeed or inertial speed components. This computation is usually performed using a Kalman estimation filter (or a similar method), so that noise, sampling or inaccuracy of measured data do not result in a fictitious wind being computed. This computation is only possible where airspeed and groundspeed/inertial data are valid. Unfortunately, it is not the case at low speed when slight changes in wind conditions have a significant impact on the helicopter behaviour. Where these data are not valid, the wind can be extrapolated between the latest and the next valid estimation. It can also be inferred from the global helicopter behaviour during the flight test.

When this computation results in strong wind gradients (quick and large change in wind direction or speed), engineering judgement should be applied in order to evaluate if the estimated wind is judged physical and realistic. If not, the computed wind should not be applied in the simulation. Indeed, unless the weather was very rough during the flight (and in such case the validity and the representativity of the reference data should be justified), the helicopter main rotor filters windshear and turbulence and strong wind gradients should not be expected as result of such computation and may be due to an incorrect estimation.

CS FSTD.QTG.H.115 Hover performance- Rotorcraft

This CS provides standards for the objective tests of rotorcraft hover performances.

1.d: Hover Performance		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.d	Hover performance	In ground effect (IGE) Out of ground effect (OGE) Light and heavy gross weights See requirements in paragraph (b) regarding height	Torque	IGE (points in IGE) OGE (points in OGE)	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Pitch angle	IGE (points in IGE) OGE (points in OGE)		Init: ±1.5° Rec: EM	Init: ±1.5° Rec: EM
			Bank angle	IGE (points in IGE) OGE (points in OGE)		Init: ±1.5° Rec: EM	Init: ±1.5° Rec: EM
			Longitudinal control position or blade angle	IGE (points in IGE) OGE (points in OGE)		Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Lateral control position or blade angle	IGE (points in IGE) OGE (points in OGE)		Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Directional control position or blade angle	IGE (points in IGE) OGE (points in OGE)		Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Collective control position or blade angle	IGE (points in IGE) OGE (points in OGE)	Init: CT&M Rec: EM	Init: ±5% Rec: EM	Init: ±5% Rec: EM

(a) Requirements for all the rotorcraft hover performance tests:

1.d: Hover Performance	Test requirements
All tests	1. Light gross weight is a weight that is not more than 120% of the basic operating weight of the reference rotorcraft, or as limited by the minimum practical operating weight of the rotorcraft. The basic operating weight is the empty weight of the rotorcraft plus the weight of the following: normal oil quantity, minimum fuel, required crew members and their baggage, standard equipment, and servicing fluids. 2. Heavy gross weight is a weight that is not less than 90% of the maximum certificated mass of the reference rotorcraft. 3. If tolerances are applied to rotor blade angles, it shall be justified that the flight control positions are consistent with the authority range of the autopilot serial actuators.

(b) Individual Test Requirements: the individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.d: Hover Performance		Test requirements
1.d	Hover performance	1. May be snapshot tests. 2. Tests shall be conducted at a minimum of three heights within the ground effect, including one at no more than 10% of the rotor diameter above the ground, one each at approximately 30% and 70% of the rotor diameter where height refers to main gear above the ground. In addition, one level flight trim condition shall be conducted out of ground effect, e.g. at 150% of rotor diameter. 3. Torque and collective blade angle (or control position) shall show correct trend versus height above ground in ground effect, and out of ground effect compared to in ground effect.

CS FSTD.QTG.H.120 Vertical climb performance - Rotorcraft

This CS provides standards for the objective tests of rotorcraft vertical climb performances.

1.e: Vertical Climb Performance		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.e	Vertical climb performance	From OGE hover Light and heavy gross weights	Vertical velocity	OGE		Init: CT&M Rec: EM	Init: ±10% or ±100 fpm (0.5 m/s) Rec: EM
			Directional control position or blade angle	OGE			Init: ±5% Rec: EM
			Collective control position or blade angle	OGE		Init: CT&M Rec: EM	Init: ±5% Rec: EM

(a) Requirements for all the rotorcraft vertical climb performance tests:

1.e: Vertical Climb Performance	Test requirements
All tests	1. Refer to test 1.d regarding the weight requirements. 2. Refer to test 1.d regarding the requirements when applying tolerances to rotor blade angles.

(b) Individual Test Requirements: the individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.e: Vertical Climb Performance		Test requirements
1.e	Vertical climb performance	1. May be snapshot tests.

CS FSTD.QTG.H.125 Level flight performance and trimmed flight control position - Rotorcraft

This CS provides standards for the objective tests for rotorcraft level flight performances and trimmed flight control position.

1.f: Level Flight Performance and Trimmed Flight Control Position		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.f	Level flight performance and trimmed flight control position	Straight cruise and level Light and heavy gross weights See requirements in paragraph (b) regarding airspeed	Torque	OGE	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM	Init: ±1.5° Rec: EM
			Sideslip angle	OGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Lateral control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Directional control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Collective control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM

(a) Requirements for all the rotorcraft level flight performance and trimmed flight control position tests:

1.f: Level Flight Performance and Trimmed Flight Control Position	Test requirements
All tests	1. Refer to test 1.d regarding the weight requirements. 2. Refer to test 1.d regarding the requirements when applying tolerances to rotor blade angles.

(b) Individual Test Requirements: the individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.f: Level Flight Performance and Trimmed Flight Control Position		Test requirements
1.f	Level flight performance and trimmed flight control position	1. At least two airspeeds (including V_Y and maximum cruise speed) within the flight envelope, for each weight configuration (minimum of 4 tests are required). 2. May be snapshot tests. 3. For a given weight and CG configuration, torque shall show correct trend versus airspeed.

CS FSTD.QTG.H.130 Climb performance and trimmed flight control position - Rotorcraft

This CS provides standards for the objective tests of rotorcraft climb performances and trimmed flight control position.

1.g: Climb Performance and Trimmed Flight Control Position		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.g	Climb performance and trimmed flight control position	All engines operating OEI Light and heavy gross weights	Vertical velocity	OGE	Init: CT&M Rec: EM	Init: ±100 fpm (0.5 m/s) or 10% Rec: EM	Init: ±100 fpm (0.5 m/s) or 10% Rec: EM
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM	Init: ±1.5° Rec: EM
			Sideslip angle	OGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Lateral control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Directional control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Collective control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Speed	OGE	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM

(a) Requirements for all the rotorcraft climb performance and trimmed flight control position tests:

1.g: Climb Performance and Trimmed Flight Control Position	Test requirements
All tests	1. Refer to test 1.d regarding the weight requirements. 2. Refer to test 1.d regarding the requirements when applying tolerances to rotor blade angles.

(b) Individual Test Requirements: the individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.g: Climb Performance and Trimmed Flight Control Position		Test requirements
1.g	Climb performance and trimmed flight control position	1. Data presented at relevant climb power conditions, for each weight/CG configuration: a. In AEO, close to maximum continuous power; b. In OEI, close to maximum power according to the selected power rating. 2. The achieved measured vertical velocity of the FSTD and of the reference data shall not be less than the appropriate approved RFM values. 3. Use of OEI training mode is allowed if corresponding performances are available in approved RFM. 4. May be snapshot tests.

CS FSTD.QTG.H.135 Performance - Descent - Rotorcraft

This CS provides standards for the objective tests of rotorcraft performances in descent.

1.h: Descent		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
1.h.1	Descent performance and trimmed flight control position	Light and heavy gross weights See requirements in paragraph (b) regarding speeds	Torque	OGE	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM	Init: ±1.5° Rec: EM
			Sideslip angle	OGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Lateral control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Directional control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Collective control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
1.h.2	Autorotation performance and trimmed flight	Steady descents Light and heavy	Vertical velocity	OGE	Init: CT&M Rec: EM	Init: ±100 fpm (0.5 m/s) or 10% Rec: EM	Init: ±100 fpm (0.5 m/s) or 10% Rec: EM

1.h: Descent		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
	control position	gross weights	Rotor speed	OGE	Init: CT&M Rec: EM	Init: ±1.5% Rec: EM	Init: ±1.5% Rec: EM
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM	Init: ±1.5° Rec: EM
			Sideslip angle	OGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Lateral control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Directional control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM
			Collective control position or blade angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5% Rec: EM

(a) Requirements for all the rotorcraft descent tests:

1.h: Descent	Test requirements
All tests	1. Refer to test 1.d regarding the weight requirements. 2. Refer to test 1.d regarding the requirements when applying tolerances to rotor blade angles.

(b) Individual Test Requirements: the individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.h: Descent		Test requirements
1.h.1	Descent performance and trimmed flight control position	1. At or near 1000 fpm (5 m/s) rate of descent (R/D) at normal approach speed. 2. May be snapshot tests.
1.h.2	Autorotation performance and trimmed flight control position	1. Rotor speed tolerance only applies if collective control position is fully down. 2. Speed sweep from approximately 50 kts to at least maximum glide distance airspeed, or maximum allowable power-off airspeed, whichever is slower, for each weight configuration (minimum of 4 tests are required). 3. May be a series of snapshot tests.

CS FSTD.QTG.H.140 Performance - Autorotational entry - Rotorcraft

This CS provides standards for the objective tests of rotorcraft performances for autorotational entry.

1.i: Autorotational Entry		**Test Conditions**	**Tolerance Parameter**	**Primary Feature(s) Validated**	**Tolerances**		
					G	**R**	**S**
1.i	Autorotational entry	Either cruise or climb	Torque	OGE	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Rotor speed	OGE	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Bank angle	OGE	Init: CT&M Rec: EM	Init: ±3° Rec: EM	Init: ±3° Rec: EM
			Heading	OGE	Init: CT&M Rec: EM	Init: ±5° Rec: EM	Init: ±5° Rec: EM
			Airspeed	OGE	Init: CT&M Rec: EM	Init: ±5 kts Rec: EM	Init: ±5 kts Rec: EM
			Altitude	OGE	Init: CT&M Rec: EM	Init: ±20 ft (6.1 m) Rec: EM	Init: ±20 ft (6.1 m) Rec: EM

(a) Individual Test Requirements: the individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.i: Autorotational Entry		**Test requirements**
1.i	Autorotational entry	1. Time history of vehicle response to a rapid power reduction to idle. If approved RFM procedure for intentional entry into autorotation does not allow rapid power reduction to idle, supplementary data (e.g. engineering data and/or subject matter expert statement) shall be provided to validate quick entry into autorotation, in addition to entry into autorotation in accordance with RFM.

1.i: Autorotational Entry		Test requirements
		2. If cruise and level, data shall be presented for the maximum range airspeed, or maximum allowable power-off airspeed, whichever is slower. 3. If climb, data shall be presented for the maximum rate of climb airspeed at or near maximum continuous power. 4. For fidelity level G only, a FSTD footprint validated by an instructor is an acceptable alternative to CT&M for initial evaluation.

CS FSTD.QTG.H.145 Performance - Landing - Rotorcraft

This CS provides standards for the objective tests of rotorcraft performances for landing.

1.j: Landing		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
1.j.1	All engines landing	Approach and landing	Airspeed	IGE	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Altitude	IGE	Init: CT&M Rec: EM	Init: ±20 ft (6.1 m) Rec: EM	Init: ±20 ft (6.1 m) Rec: EM
			Torque	IGE	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Rotor speed	IGE	Init: CT&M Rec: EM	Init: ±1.5% Rec: EM	Init: ±1.5% Rec: EM
			Pitch angle	IGE	Init: CT&M Rec: EM	Init: ±2.5° Rec: EM	Init: ±1.5° Rec: EM
			Bank angle	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±1.5° Rec: EM
			Heading	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Lateral control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Directional control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM

1.j: Landing		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Collective control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
1.j.2	OEI landing	Approach and landing	Airspeed	IGE	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Altitude	IGE	Init: CT&M Rec: EM	Init: ±20 ft (6.1 m) Rec: EM	Init: ±20 ft (6.1 m) Rec: EM
			Torque	IGE	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Rotor speed	IGE	Init: CT&M Rec: EM	Init: ±1.5% Rec: EM	Init: ±1.5% Rec: EM
			Pitch angle	IGE	Init: CT&M Rec: EM	Init: ±2.5° Rec: EM	Init: ±1.5° Rec: EM
			Bank angle	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±1.5° Rec: EM
			Heading	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Lateral control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Directional control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM

1.j: Landing		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Collective control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
1.j.3	Balked landing/missed approach	OEI approach	Airspeed	IGE	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Altitude	IGE	Init: CT&M Rec: EM	Init: ±20 ft (6.1 m) Rec: EM	Init: ±20 ft (6.1 m) Rec: EM
			Torque	IGE	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Rotor speed	IGE	Init: CT&M Rec: EM	Init: ±1.5% Rec: EM	Init: ±1.5% Rec: EM
			Pitch angle	IGE	Init: CT&M Rec: EM	Init: ±2.5° Rec: EM	Init: ±1.5° Rec: EM
			Bank angle	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±1.5° Rec: EM
			Heading	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Lateral control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Directional control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM

1.j: Landing		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Collective control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
1.j.4	Autorotational landing with touch down	Approach and touch down	Airspeed	IGE		Init: CT&M Rec: EM	Init: ±3 kts Rec: EM
			Torque	IGE		Init: CT&M Rec: EM	Init: ±3% Rec: EM
			Rotor speed	IGE		Init: CT&M Rec: EM	Init: ±3% Rec: EM
			Altitude	IGE		Init: CT&M Rec: EM	Init: ±20 ft (6.1 m) Rec: EM
			Pitch angle	IGE		Init: CT&M Rec: EM	Init: ±2° Rec: EM
			Bank angle	IGE		Init: CT&M Rec: EM	Init: ±2° Rec: EM
			Heading	IGE		Init: CT&M Rec: EM	Init: ±5° Rec: EM
			Longitudinal control position	IGE		Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Lateral control position	IGE		Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Directional control position	IGE		Init: CT&M Rec: EM	Init: ±10% Rec: EM

1.j: Landing		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Collective control position	IGE		Init: CT&M Rec: EM	Init: ±10% Rec: EM
1.j.5	Hover to touchdown	IGE hover	Torque	IGE	Init: CT&M Rec: EM	Init: ±5% Rec: EM	Init: ±5% Rec: EM
			Pitch angle	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Bank angle	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Heading	IGE	Init: CT&M Rec: EM	Init: ±3° Rec: EM	Init: ±3° Rec: EM
			Longitudinal control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Lateral control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Directional control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Collective control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
1.j.6	Level flight acceleration	From hover to Vy	Airspeed	IGE	Init: CT&M Rec: EM	Init: ±3 kts Rec: EM	Init: ±3 kts Rec: EM
			Torque	IGE	Init: CT&M Rec: EM	Init: ±3% Rec: EM	Init: ±3% Rec: EM

1.j: Landing		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Pitch angle	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Bank angle	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Heading	IGE	Init: CT&M Rec: EM	Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Lateral control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Directional control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Collective control position	IGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM

(a) Requirements for all the rotorcraft landing tests:

1.j: Landing	Test requirements
All tests	1. Wind conditions shall be justified. In addition, if wind is not constant during the test, it shall be plotted. 2. For fidelity level G only, a FSTD footprint validated by an instructor is an acceptable alternative to CT&M for initial evaluation.

(b) Individual Test Requirements: the individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

1.j: Landing		Test requirements
1.j.1	All engines landing	1. Time history of approach and landing to a hover. 2. When airspeed is not valid or not reliable, tolerance shall be applied to groundspeed instead. 3. If/when pressure-altitude becomes unreliable due to rotor downwash, height above ground shall be used instead. As an alternative, GNSS altitude above ellipsoid can be used (with initial offset compensated) instead of pressure-altitude during the whole test.
1.j.2	OEI landing	1. Time history of approach and landing to touchdown. 2. If/when airspeed is not valid or not reliable, tolerance shall be applied to groundspeed instead. 3. If/when pressure-altitude becomes unreliable due to rotor downwash, height above ground shall be used instead. As an alternative, GNSS altitude above ellipsoid can be used (with initial offset compensated) instead of pressure-altitude during the whole test.
1.j.3	Balked landing/missed approach	1. From a stabilised approach at the landing decision point (LDP). 2. If/when airspeed is not valid or not reliable, tolerance shall be applied to groundspeed instead.
1.j.4	Autorotational landing with touch down	1. Time history of autorotational deceleration and touch down from a stabilised autorotational descent. 2. If/when airspeed is not valid or not reliable, tolerance shall be applied to groundspeed instead. 3. If/when pressure-altitude becomes unreliable due to rotor downwash, height above ground shall be used instead. As an alternative, GNSS altitude above ellipsoid can be used (with initial offset compensated) instead of pressure-altitude during the whole test. 4. If full autorotation landing cannot be safely performed or is not allowed by RFM, an alternate manoeuvre can be used: a. a simulated autorotational flare and reduction of rate of descent (RoD) at altitude; or b. a power-on termination following an autorotational approach and flare. In such a case, full autorotation landing shall be subjectively assessed by a TRI/TRE and a footprint test shall also be provided.
1.j.5	Hover to touchdown	1. Record a manoeuvre starting from IGE hover till touchdown ending with collective control full down.
1.j.6	Level flight acceleration	1. Record a coordinated level flight acceleration with a minimum approximate speed range increase from hover to V_Y initiated with a single power increase at the beginning of the manoeuvre (not a continuous). 2. When airspeed is not valid or not reliable, tolerance shall be applied to groundspeed instead.

GM1 FSTD.QTG.H.145 Performance - Landing - Rotorcraft

See GM1 FSTD.QTG.H.110.

CS FSTD.QTG.H.200 Handling qualities - Control system mechanical characteristics - Rotorcraft

This CS provides standards for the objective tests of rotorcraft control system mechanical characteristics.

2.a: Control system mechanical characteristics		**Test Conditions**	**Tolerance Parameter**	**Primary Feature(s) Validated**	**Tolerances**		
					G	**R**	**S**
2.a.1	Cyclic force vs. position	Static on ground Trim on and off Friction off Longitudinal and lateral	Breakout force	CLH	Init: CT&M Rec: ±25% or ±0.25 lb (0.1120 daN)	Init: ±25% or ±0.25 lb (0.1120 daN) Rec: same as Init	Init: ±25% or ±0.25 lb (0.1120 daN) Rec: same as Init
			Force	CLH	Init: CT&M Rec: ±10% or ±0.5 lb (0.2224 daN)	Init: ±10% or ±0.5 lb (0.2224 daN) Rec: same as Init	Init: ±10% or ±0.5 lb (0.2224 daN) Rec: same as Init
			Control range	CLH	Init: CT&M Rec: ±1.5% of total travel or ±3 mm	Init: ±1.5% of total travel or ±3 mm Rec: same as Init	Init: ±1.5% of total travel or ±3 mm Rec: same as Init
2.a.2	Collective/pedals force vs. position	Static on ground Trim on and off Friction off Collective and pedals	Breakout force	CLH	Init: CT&M Rec: ±25% or ±0.5 lb (0.2224 daN)	Init: ±25% or ±0.5 lb (0.2224 daN) Rec: same as Init	Init: ±25% or ±0.5 lb (0.2224 daN) Rec: same as Init
			Force	CLH	Init: CT&M Rec: ±10% or ±1 lb (0.4448 daN)	Init: ±10% or ±1 lb (0.4448 daN) Rec: same as Init	Init: ±10% or ±1 lb (0.4448 daN) Rec: same as Init
			Control range	CLH	Init: CT&M Rec: ±1.5% of total travel or ±3 mm	Init: ±1.5% of total travel or ±3 mm Rec: same as Init	Init: ±1.5% of total travel or ±3 mm Rec: same as Init

2.a: Control system mechanical characteristics		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.a.3	Brake pedal force vs. position	Static on ground	Force	CLH			Init: ±10% or ±5 lb (2.224 daN) Rec: same as Init
			Control range	CLH			Init: ±1.5% of total travel or ±3 mm Rec: same as Init
2.a.4	Trim system rate	Static on ground Trim on Friction off All applicable axes, in both directions for each axis	Trim rate	CLO, CLH	Init: CT&M Rec: ±10%	Init: ±10% Rec: same as Init	Init: ±10% Rec: same as Init
2.a.5	Control dynamics - dynamic releases	See requirements in paragraph (b) regarding flight conditions All applicable axes, in both directions for each axis Trim on Friction off	For underdamped systems, all the following tolerance parameters:				
			P_0: time from 90% of initial displacement (A_d) to first zero crossing)	CLH			Init: ±10% or 0.05 s Rec: same as Init
			P_1: period of the 1st oscillation	CLH			Init: ±20% or 0.05 s Rec: same as Init
			P_2: period of the 2nd oscillation	CLH			Init: ±30% or 0.05 s Rec: same as Init

2.a: Control system mechanical characteristics		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
		Stability augmentation on and off	P_n: period of the n^{th} oscillation	CLH			Init: ±10(n+1)% or ±0.05 s Rec: same as Init
			A_n: Amplitude of the n^{th} significant overshoot (outside the residual band)	CLH			Init: ±10% of the amplitude of the largest overshoot (A_{max}) or ±0.5% of the total control travel (stop to stop) Rec: same as Init
			Number of significant overshoots	CLH			Init: ±1 (minimum of 1 significant overshoot) Rec: same as Init
			For overdamped and critically damped systems:				
			P_0: time from 90% of initial displacement (A_d) to 10% of A_d	CLH			Init: ±10% or 0.05 s Rec: same as Init

2.a: Control system mechanical characteristics		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
	Control dynamics - sweeps	Static on ground All applicable axes, slow and fast sweeps Trim on Friction off	Force	CLH		Init: ±0.9 daN (2 lb) or ±10% on the dynamic increment above static test Rec: same as Init	
2.a.6	Free play	Static on ground Friction off All axes	Freeplay	CLH	Init: CT&M Rec: ±0.1 in (2.5 mm)	Init: CT&M Rec: ±0.1 in (2.5 mm)	Init: from 0 to reference data +0.1 in (2.5 mm) Rec: ±0.1 in (2.5 mm)
2.a.7	Rotor blade angle versus control position	Static on ground, rotors not turning Stability augmentation off All axes	Blade angle or equivalent	CLO	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: CT&M Rec: EM

(a) Requirements for all the rotorcraft control system mechanical characteristics tests:

2.a: Control system mechanical characteristics	Test requirements
All tests	1. Tests are required also from the second set of pilot controls only if both sets of controls are not mechanically interconnected on the FSTD. A rationale is required from the data provider if a single set of data is applicable to both

2.a: Control system mechanical characteristics	Test requirements
	sides. If controls are mechanically interconnected in the FSTD, a single set of tests is sufficient if properly justified. 2. For the control sweep tests (tests 2.a.1, 2.a.2 and 2.a.3), where there is a steep force gradient near control stops, the force tolerance does not apply. 3. With the hydraulic system (if applicable) pressurised. Supplemental hydraulic pressurisation system may be used. 4. Force and position shall be measured at the controls. An alternate method acceptable to the competent authority in lieu of the test fixture at the controls would be to instrument the FSTD in an equivalent manner to the flight test rotorcraft. The force and position data from instrumentation can be directly recorded and matched to the rotorcraft data. Such a permanent installation could be used without requiring any time for installation of external devices. 5. The static control checks must be conducted manually if the FSTD control positions are not back driven by the control loading.

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.a: Control system mechanical characteristics		Test requirements
2.a.1	Cyclic force vs. position	1. Uninterrupted control sweeps. 2. This test is not required for aircraft hardware modular controllers.
2.a.2	Collective/pedals force vs. position	1. Uninterrupted control sweeps. 2. This test is not required for aircraft hardware modular controllers.
2.a.4	Trim system rate	1. Feature CLO is applicable when autopilot, stability augmentation system or similar equipment is involved in trim actuation.
2.a.5	Control dynamics - dynamic releases	1. Control dynamics tests shall be performed in hover and in cruise. a. Control dynamics for reversible control systems shall be evaluated in flight considering safety issues or using an alternate method to be proposed to and agreed with the NAA on a case-by-case basis. b. For irreversible control systems, control dynamics tests may be evaluated in a ground/static condition, if proper pitot-static inputs (if applicable) are provided to represent airspeeds typical of those encountered in flight.

2.a: Control system mechanical characteristics		Test requirements
		2. Data shall be for a normal control displacement in both directions in each axis, approximately 25% to 50% of full throw (rest position to stop), or that necessary for proper excitation. 3. n is the sequential period of a full cycle of oscillation. 4. The amplitude of the residual band is ±5% of the initial displacement (A_d), or ±0.5% of the total control travel (stop to stop), whichever is greater. Oscillations within the residual band are not considered significant and are not subject to tolerances. 5. Measure the free response of the controls using a step input or pulse input to excite the system.
	Control dynamics - sweeps	1. The method applies to rotorcraft with hydraulically powered flight controls and artificial feel systems. Instead of free response measurements, the system is validated by measurements of control force and rate of movement. 2. The control shall be forced to its maximum extreme position for the following distinct rates: a. Static test: refer to tests 2.a.1 and 2.a.2. b. Slow dynamic sweep: achieve a full sweep in approximately 10 s. c. Fast dynamic sweep: achieve a full sweep in approximately 4 s. 3. Dynamic sweeps may be limited to forces not exceeding 44.5 daN (100 lb).
2.a.7	Rotor blade angle versus control position	1. Acceptable alternatives for blade angles are actuators extension or swashplate attitudes. For fidelity level G, rotor disc attitudes are acceptable. 2. Can be combined with tests 2.a.1 and 2.a.2.

GM1 FSTD.QTG.H.200 Handling Qualities - Control system mechanical characteristics - Rotorcraft

All tests related to control system mechanical characteristics should be performed in an integrated manner, so that:

- the measured controls positions and forces are representative of what the crew feels hands on control;
- significant changes in the control mechanical characteristics (e.g. increased mechanical friction) or to the control software are reflected in the results of the tests when run in manual and in automatic mode.

Test fixture at the control (similar test installation as the one used to measure data on the reference rotorcraft) is generally the most comprehensive way for measuring flight controls mechanical characteristics. However, it may not be efficient or practical to install such an external test bench every time running a test is required. Therefore, a permanent instrumentation of the FSTD that provides similar results as an external test fixture may be suitable.

It should be justified that the FSTD instrumentation is comparable to an external test fixture. This can be achieved by providing a calibration test for each axis that was run concurrently with the external and the internal instrumentation; the calibration test of the internal instrumentation should be performed both in automatic and in manual mode. Once established, it should not be necessary to perform this comparison on a regular basis.

When the test is run in automatic mode, the system should take into account both the calculated forces and the measured mechanical forces when moving the control. Any change in friction, inertia, presence of an obstacle should be visible in the test results. It should be able to demonstrate this safely by holding the control during an automatic test: the test results should show an increase of the forces where the control was held.

In manual mode, the FSTD instrumentation is generally not capable of measuring the mechanical loads introduced between the control grip and the force sensor. Therefore, manual test mode is useful for assessing the validity of the internal instrumentation but may not be sufficient to detect all changes in control loads.

If there are control boots, in order to measure consistent results, it is acceptable to either remove them or loosen them.

In addition, refer to GM1 FSTD.QTG.A.205 'Handling Qualities Dynamic Control Checks - Aeroplane', which is also applicable to rotorcraft.

CS FSTD.QTG.H.205 Low airspeed handling qualities - Rotorcraft

This CS provides standards for the objective tests of rotorcraft low airspeed handling qualities.

2.b: Handling - Low airspeed		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.b.1	Trimmed flight control positions	Translational flight IGE Sideways, rearward and forward See requirements in paragraph (a) regarding groundspeed	Torque	IGE		Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Pitch angle	IGE		Init: ±1.5° Rec: EM	Init: ±1.5° Rec: EM
			Bank angle	IGE		Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position or blade angle	IGE, CLO		Init: ±5% Rec: EM	Init: ±5% Rec: EM
			Lateral control position or blade angle	IGE, CLO		Init: ±5% Rec: EM	Init: ±5% Rec: EM
			Directional control position or blade angle	IGE, CLO		Init: ±5% Rec: EM	Init: ±5% Rec: EM
			Collective control position or blade angle	IGE, CLO		Init: ±5% Rec: EM	Init: ±5% Rec: EM
2.b.2	Critical azimuth	Stationary hover IGE	Torque	IGE		Init: ±3% Rec: EM	Init: ±3% Rec: EM
			Pitch angle	IGE		Init: ±1.5° Rec: EM	Init: ±1.5° Rec: EM

2.b: Handling - Low airspeed		**Test Conditions**	**Tolerance Parameter**	**Primary Feature(s) Validated**	**Tolerances**		
					G	**R**	**S**
		See requirements in paragraph (a) regarding relative wind direction	Bank angle	IGE		Init: ±2° Rec: EM	Init: ±2° Rec: EM
			Longitudinal control position or blade angle	IGE, CLO		Init: ±5% Rec: EM	Init: ±5% Rec: EM
			Lateral control position or blade angle	IGE, CLO		Init: ±5% Rec: EM	Init: ±5% Rec: EM
			Directional control position or blade angle	IGE, CLO		Init: ±5% Rec: EM	Init: ±5% Rec: EM
			Collective control position or blade angle	IGE, CLO		Init: ±5% Rec: EM	Init: ±5% Rec: EM
2.b.3.a	Longitudinal control response	Hover Stability augmentation on and off	Pitch rate	IGE, OGE	Init: CT&M Rec: EM	Init: ±10% or ±2°/s Rec: EM	Init: ±10% or ±2°/s Rec: EM
			Pitch angle change	IGE, OGE	Init: CT&M Rec: EM	Init: ±10% or ±1.5° Rec: EM	Init: ±10% or ±1.5° Rec: EM
2.b.3.b	Lateral control response	Hover Stability augmentation on and off	Roll rate	IGE, OGE	Init: CT&M Rec: EM	Init: ±10% or ±3°/s Rec: EM	Init: ±10% or ±3°/s Rec: EM
			Bank angle change	IGE, OGE	Init: CT&M Rec: EM	Init: ±10% or ±3° Rec: EM	Init: ±10% or ±3° Rec: EM

2.b: Handling - Low airspeed		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.b.3.c	Directional control response	Hover	Yaw rate	IGE, OGE	Init: CT&M Rec: EM	Init: ±10% or ±2°/s Rec: EM	Init: ±10% or ±2°/s Rec: EM
		Both directions Stability augmentation on and off	Heading change	IGE, OGE	Init: CT&M Rec: EM	Init: ±10% or ±2° Rec: EM	Init: ±10% or ±2° Rec: EM
			Altitude or height or vertical speed	IGE, OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: CT&M Rec: EM
2.b.3.d	Vertical control response	Hover Stability augmentation on and off	Normal acceleration	IGE, OGE	Init: CT&M Rec: EM	Init: ±0.1 g Rec: EM	Init: ±0.1 g Rec: EM
			Vertical speed	IGE, OGE	Init: CT&M Rec: EM	Init: ±10% or ±100 fpm (0.5 m/s) Rec: EM	Init: ±10% or ±100 fpm (0.5 m/s) Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.b: Handling - Low airspeed		Test requirements
2.b.1	Trimmed flight control positions	1. Several ground speed increments to translational airspeed limits and 45 kts forward. 2. May be a series of snapshot tests. 3. Stable flight conditions shall be reached at each airspeed increment. 4. If tolerances are applied to rotor blade angles, it shall be justified that the flight control positions are consistent with the authority range of the autopilot serial actuators.
2.b.2	Critical azimuth	1. Present data for three relative wind directions (including the most critical case) in the critical quadrant. 2. May be a series of snapshot tests. The data provider must ensure that a steady state condition exists at the instant of time captured by the 'snapshot'. The steady state condition must exist from 4 seconds prior to through 1 second following the instant of time captured by the snapshot. 3. Precise wind measurement is very difficult and simulated wind obtained by translational flight in calm weather

2.b: Handling - Low airspeed		Test requirements
		condition (no wind) is preferred in order to control precisely flight conditions by using groundspeed measurement (usually GNSS). In this condition, it would be more practical to realise this test with tests 2.b.1 in order to ensure consistency between critical azimuth and other directions (forward, sideward and rearward). In case tests 2.b.1 and 2.b.2 are performed concurrently in calm weather condition, then only one azimuth (the most critical one). is required for test 2.b.2. 4. When not defined in the RFM, the critical azimuth shall be defined either as the azimuth with minimum directional control margin or as the azimuth with maximum instability. 5. If tolerances are applied to rotor blade angles, it shall be justified that the flight control positions are consistent with the authority range of the autopilot serial actuators.
2.b.3.a	Longitudinal control response	1. Step control input. 2. Attitude change is defined as the difference between the current attitude and the stable attitude prior to the step input. 3. The tolerance on attitude change is applied continuously from the time of the step input. 4. This is a short-term response test. 5. Reference data IGE are preferred since pilot has a better reference. However, for safety reasons, reference data OGE are also acceptable. Only one test (either IGE or OGE) is required.
2.b.3.b	Lateral control response	1. Step control input. 2. Attitude change is defined as the difference between the current attitude and the stable attitude prior to the step input. 3. The tolerance on attitude change is applied continuously from the time of the step input. 4. This is a short-term response test. 5. Reference data IGE are preferred since pilot has a better reference. However, for safety reasons, reference data OGE are also acceptable. Only one test (either IGE or OGE) is required.
2.b.3.c	Directional control response	1. Step control input. 2. Heading change is defined as the difference between the current heading and the stable heading prior to the step input. 3. The tolerance on heading change is applied continuously from the time of the step input. 4. This is a short-term response test.

2.b: Handling - Low airspeed		Test requirements
		5. Reference data IGE are preferred since pilot has a better reference. However, for safety reasons, reference data OGE are also acceptable. Only one test (either IGE or OGE) is required for each direction (total of 2 tests).
2.b.3.d	Vertical control response	1. Step control input. 2. This is a short-term response test. 3. Reference data IGE are preferred since pilot has a better reference. However, for safety reasons, reference data OGE are also acceptable. Only one test (either IGE or OGE) is required.

GM1 FSTD.QTG.H.205 Low Airspeed Handling Qualities - Rotorcraft

In order to better demonstrate the influence of airspeed on trimmed flight control position, it is recommended that test 2.b.1 contains snapshots of stable conditions every 10 kts approximately, with other flight conditions unchanged.

In order to better demonstrate the critical azimuth, it is recommended that the airspeed is chosen close to translational limits in the critical quadrant, within the flight envelope.

CS FSTD.QTG.H.210 Longitudinal handling qualities - Rotorcraft

This CS provides standards for the objective tests of rotorcraft longitudinal handling qualities.

2.c: Handling - Longitudinal		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
2.c.1	Control response	Straight cruise and level Stability augmentation on and off See requirements in paragraph (a) regarding airspeed	Pitch rate	OGE	Init: CT&M Rec: EM	Init: ±10% or ±2°/s Rec: EM	Init: ±10% or ±2°/s Rec: EM
			Pitch angle change	OGE	Init: CT&M Rec: EM	Init: ±10% or ±1.5° Rec: EM	Init: ±10% or ±1.5° Rec: EM
2.c.2	Static stability	Either straight cruise and level, or straight cruise climb Autorotation See requirements in paragraph (a) regarding airspeed	Longitudinal control position change from trim	OGE, CLO	Init: CT&M Rec: EM	Init: ±10% or ±6.3 mm (0.25 in) REC: EM	Init: ±10% or ±6.3 mm (0.25 in) REC: EM
			Or				
			Longitudinal control force change from trim	OGE, CLO	Init: CT&M Rec: EM	Init: ±10% or ±0.2224 daN (0.5 lb) Rec: EM	Init: ±10% or ±0.2224 daN (0.5 lb) Rec: EM
2.c.3.a	Dynamic stability - long term response (Phugoid dynamics)	Straight cruise and level Stability augmentation off	If behaviour is periodic				
			Period	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% or ±0.5 s Rec: EM
			Additionally, one of the following tolerance parameters:				

2.c: Handling - Longitudinal		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
			Time to ½ or double amplitude	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Damping ratio	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±0.02 Rec: EM
			If behaviour is non-periodic				
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±3° Rec: EM
			Airspeed	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5 kts Rec: EM
2.c.3.b	Dynamic stability - short term response	Straight cruise flight, either level or climb Stability augmentation on and off See requirements in paragraph (a) regarding airspeed	Normal acceleration	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±0.1 g Rec: EM
			Additionally, one of the following tolerance parameters:				
			Pitch angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±1.5° Rec: EM
			Pitch rate	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±2°/s Rec: EM
2.c.4	Manoeuvering stability	Either cruise or climb	Longitudinal control position change from trim	OGE, CLO		Init: CT&M Rec: EM	Init: ±10% or ±6.3 mm (0.25 in) REC: EM
			Or				

2.c: Handling - Longitudinal		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
		Stability augmentation on and off Left and right turns See requirements in paragraph (a) regarding airspeed	Longitudinal control force change from trim	OGE, CLO		Init: CT&M Rec: EM	Init: ±10% or ±0.2224 daN (0.5 lb) Rec: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.c: Handling - Longitudinal		Test requirements
2.c.1	Control response	1. Two cruise airspeeds to include minimum power required speed. 2. Step control input. 3. Attitude change is defined as the difference between the current attitude and the stable attitude prior to the step input. 4. The tolerance on attitude change is applied continuously from the time of the step input.
2.c.2	Static stability	1. Minimum of two speeds on each side of the trim speed, with a minimum gap of 5 kts between two consecutive speeds. The rotorcraft is first stabilised in straight cruise and level flight at an initial airspeed, this condition is identified as the reference trim speed. From this reference trim condition, four additional stable straight cruise conditions are reached, two with different airspeeds greater than reference trim speed and two with different airspeeds lower than reference trim speed; they can be reached in any order. For the demonstration of the rotorcraft static stability, it is recommended that collective / power is unchanged when stabilising the four additional cruise conditions with increased or decreased airspeed; therefore, only the reference trim condition will be in level flight, the additional stable cruise conditions will be in climb or in descent. 2. May be a series of snapshot tests.

2.c: Handling - Longitudinal		Test requirements
		3. Stability augmentation on and off conditions are required if the augmentation system includes airspeed regulation. 4. Control position change from trim is defined as the difference between the current control position and the position at the reference trim speed. 5. When presented as a series of snapshot tests, tolerance on control position change from trim does not apply to reference trim speed snapshot, but only to the four subsequent snapshots. A minimum of 10 snapshot tests are required (5 for each speed), with tolerances applied to 8 of them. 6. When presented as time histories, the tolerance on control position change from trim is applied continuously from the time the reference trim condition is reached. 7. In order to demonstrate static stability, the sign of the control position change from trim shall match: with other flight conditions being unchanged, in order to increase (resp. decrease) airspeed, cyclic control shall be moved forward (resp. aft). 8. For rotorcraft with force trim release, or follow-up trim, or any function that affects the control force and/or the trim position, this function shall be disengaged to be able to apply tolerance to control force. Otherwise, tolerance shall be applied to flight control position change from trim.
2.c.3.a	Dynamic stability - long term response (Phugoid)	1. Time history to validate long term rotorcraft response (phugoid). Generally, this can be demonstrated with a control doublet input. This test shall be performed even if the phugoid cannot be made apparent on the reference rotorcraft. 2. Test shall include three full cycles (6 overshoots after input completed) or that sufficient to determine time to ½ or double amplitude, whichever is less. When rotorcraft behaviour diverges, test shall end before unsafe attitudes are reached. If rotorcraft longitudinal long term response gets masked by off-axis behaviour (e.g. if/when phugoid is masked by dutch roll), test shall end when longitudinal proper mode is no more apparent. 3. For non-periodic response, or when period and damping ratio cannot be determined due to rotorcraft behaviour, the time history shall be matched. Test shall last 20 s after control release.
2.c.3.b	Dynamic stability - short term response	1. Two cruise airspeeds. 2. Time history to validate short term rotorcraft response due to control pulse input. 3. Check to stop 4 seconds after completion of input. When rotorcraft behaviour diverges, test shall end before unsafe attitudes are reached.
2.c.4	Manoeuvering	1. Force may be a cross plot for irreversible systems.

2.c: Handling - Longitudinal		Test requirements
	stability	2. Two airspeeds. 3. May be a series of snapshot tests. 4. Approximately 30° and 45° bank angle data shall be presented. 5. The rotorcraft is first stabilised in straight cruise and level flight at a first airspeed. Then, the rotorcraft is stabilised at approximately 30° and 45°, left and right (in any order), while keeping the airspeed constant. It is recommended that collective / power is unchanged when stabilising these four turn conditions, which may not be in level flight anymore. Repeat the above test conditions at a second airspeed. 6. When presented as a series of snapshot tests, tolerance on control position change from trim does not apply to reference trim snapshot in straight flight, but only to the subsequent snapshots in left and right turn. A total of 10 snapshot tests are required (5 for each speed), with tolerances applied to 8 of them. 7. For each speed condition, the control position change from trim is defined as the difference between the current control position and the initial stable control position in straight and level flight. 8. For rotorcraft with force trim release, or follow-up trim, or any function that affects the control force and/or the trim position, this function shall be disengaged to be able to apply tolerance to control force. Otherwise, tolerance shall be applied to flight control position change from trim.

CS FSTD.QTG.H.215 Lateral and directional handling qualities - Rotorcraft

This CS provides standards for the objective tests of rotorcraft longitudinal handling qualities.

2.d: Handling - Lateral and directional		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.d.1.a	Control response - Lateral	Straight cruise and level Stability augmentation on and off See requirements in paragraph (a) regarding airspeed	Roll rate	OGE	Init: CT&M Rec: EM	Init: ±10% or ±3°/s Rec: EM	Init: ±10% or ±3°/s Rec: EM
			Bank angle change	OGE	Init: CT&M Rec: EM	Init: ±10% or ±3° Rec: EM	Init: ±10% or ±3° Rec: EM
2.d.1.b	Control response - Directional	Straight cruise and level Stability augmentation on and off See requirements in paragraph (a) regarding airspeed	Yaw rate	OGE	Init: CT&M Rec: EM	Init: ±10% or ±2°/s Rec: EM	Init: ±10% or ±2°/s Rec: EM
			Heading change	OGE	Init: CT&M Rec: EM	Init: ±10% or ±2° Rec: EM	Init: ±10% or ±2° Rec: EM
2.d.2	Static stability		One of the following tolerance parameters:				
			Bank angle	OGE	Init: CT&M Rec: EM	Init: ±1.5° REC: EM	Init: ±1.5° REC: EM

2.d: Handling - Lateral and directional		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
		Straight cruise flight, either level, or both climb and descent See requirements in paragraph (a) regarding sideslip	Lateral load factor	OGE	Init: CT&M Rec: EM	Init: 0.026 g REC: EM	Init: ±0.026 g REC: EM
			Additionally, one of the following tolerance parameters:				
			Longitudinal control position change from trim	OGE, CLO	Init: CT&M Rec: EM	Init: ±10% or ±6.3 mm (0.25 in) REC: EM	Init: ±10% or ±6.3 mm (0.25 in) REC: EM
			Longitudinal control force change from trim	OGE, CLO	Init: CT&M Rec: EM	Init: ±10% or ±0.2224 daN (0.5 lb) Rec: EM	Init: ±10% or ±0.2224 daN (0.5 lb) Rec: EM
			Additionally, one of the following tolerance parameters:				
			Lateral control position change from trim	OGE, CLO	Init: CT&M Rec: EM	Init: ±10% or ±6.3 mm (0.25 in) REC: EM	Init: ±10% or ±6.3 mm (0.25 in) REC: EM
			Lateral control force change from trim	OGE, CLO	Init: CT&M Rec: EM	Init: ±10% or ±0.2224 daN (0.5 lb) Rec: EM	Init: ±10% or ±0.2224 daN (0.5 lb) Rec: EM
			Additionally, one of the following tolerance parameters:				
			Directional control position change from trim	OGE, CLO	Init: CT&M Rec: EM	Init: ±10% or ±6.3 mm (0.25 in) REC: EM	Init: ±10% or ±6.3 mm (0.25 in) REC: EM

2.d: Handling - Lateral and directional		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
			Directional control force change from trim	OGE, CLO	Init: CT&M Rec: EM	Init: ±10% or ±0.4448 daN (1 lb) Rec: EM	Init: ±10% or ±0.4448 daN (1 lb) Rec: EM
2.d.3.a	Dynamic stability - lateral and directional oscillations (Dutch roll)	Straight cruise flight, either level or climb Stability augmentation on and off	For periodic response, the following tolerance parameters:				
			Period	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% or ±0.5 s Rec: EM
			Time difference between peaks of bank and sideslip	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±20% or ±1 s Rec: EM
			Additionally, one of the following tolerance parameters:				
			Time to ½ or double amplitude	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10% Rec: EM
			Damping ratio	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±0.02 Rec: EM
			For non-periodic response, all the following tolerance parameters:				
			Airspeed	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±10 kts Rec: EM
			Bank angle	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±5° Rec: EM
			Heading	OGE	Init: CT&M Rec: EM	Init: CT&M Rec: EM	Init: ±4° Rec: EM
2.d.3.b	Reserved						

2.d: Handling - Lateral and directional		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
2.d.3.c	Dynamic stability - adverse/proverse yaw	Straight cruise flight, either level or climb Stability augmentation on and off Left and right turns	Sideslip	OGE			Init: ±2° REC: EM
			Or all the following tolerance parameters:				
			Bank angle	OGE			Init: ±2° Rec: EM
			Heading	OGE			Init: ±3° Rec: EM
			Lateral load factor	OGE			Init: ±0.052 g REC: EM

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

2.d: Handling - Lateral and directional		Test requirements
2.d.1.a	Control response - Lateral	1. Two airspeeds to include one at or near the minimum power required speed. 2. Step control input. 3. Attitude change is defined as the difference between the current attitude and the stable attitude prior to the input. 4. The tolerance on attitude change is applied continuously from the time of the step input.
2.d.1.b	Control response - Directional	1. Two airspeeds to include one at or near the minimum power required speed. 2. Step control input. 3. Heading change is defined as the difference between the current heading and the stable heading prior to the step input. 4. The tolerance on heading change is applied continuously from the time of the step input.
2.d.2	Static stability	1. Steady heading sideslip. 2. Minimum of two sideslip angles on either side of the trim point. The rotorcraft is first stabilised in straight flight, this condition is identified as the reference trim.

2.d: Handling - Lateral and directional		Test requirements
		From this reference trim condition, four additional stable straight cruise conditions are reached, two with different left sideslip and two with different right sideslip; they can be reached in any order. For the demonstration of the rotorcraft static stability, it is recommended that collective / power is unchanged when stabilising the four additional sideslip conditions; therefore, if initially in level flight (respectively climb, descent), rotorcraft may no more be in level flight (respectively climb, descent) when stabilised with sideslip. 3. If initial conditions are not level flight, then both climb and descent conditions shall be presented. 4. Force may be a cross plot for irreversible control systems. 5. May be a series of snapshot tests. 6. Control position change from trim is defined as the difference between the current control position and the position at the reference trim. 7. When presented as a series of snapshot tests, tolerance on control position change from trim does not apply to reference trim speed snapshot, but only to the four subsequent snapshots. A minimum of 5 snapshot tests are required if cruise and level flight conditions are chosen. A minimum of 10 snapshot tests (5 in climb and 5 in descent) are required if climb and descent flight conditions are chosen. 8. When presented as time histories, the tolerance on control position change from trim is applied continuously from the time the reference trim condition is reached. 9. For rotorcraft with force trim release, or follow-up trim, or any function that affects the control force and/or the trim position, this function shall be disengaged to be able to apply tolerances to control forces. Otherwise, tolerances shall be applied to flight controls positions change from trim.
2.d.3.a	Dynamic stability - lateral and directional oscillations (Dutch roll)	1. Two cruise airspeeds. 2. Time history to validate long term rotorcraft response (Dutch roll). Excite with cyclic or pedal doublet. This test shall be performed even if the Dutch roll cannot be made apparent on the reference rotorcraft. 3. Test shall include six full cycles (12 overshoots after input completed) or that sufficient to determine time to ½ or double amplitude, whichever is less. When rotorcraft behaviour diverges, test shall end before unsafe attitudes are reached. If rotorcraft longitudinal long term response gets masked by off-axis behaviour, test shall end when lateral/directional proper mode is no more apparent. 4. For non-periodic response, or when period and damping ratio cannot be determined due to rotorcraft behaviour, test

2.d: Handling - Lateral and directional		Test requirements
		shall last 20 s after control release.
2.d.3.c	Dynamic stability - adverse/proverse yaw	1. Time history of initial entry into uncoordinated turns in both directions. Use moderate control input rate. From a stable straight cruise and level flight condition, rotorcraft enters uncoordinated turn in one direction, using either pedal-only or cyclic-only input. The whole manoeuvre is repeated for the opposite turn direction. 2. Adverse yaw is the tendency of the rotorcraft to yaw in the opposite direction to the roll. Proverse yaw is the tendency of the rotorcraft to yaw in the same direction as the roll.

CS FSTD.QTG.H.300 Motion system - Rotorcraft

This CS provides standards for the objective tests of rotorcraft motion systems.

3: Motion System		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
3.a	Frequency response	N/A	Phase	MTN		Init: 0° to -20° between 0.1 and 1.0 Hz, 0° to -40° between 1.0 and 3.0 Hz Rec: Same as Init	Init: 0° to -20° between 0.1 and 1.0 Hz, 0° to -40° between 1.0 and 3.0 Hz Rec: Same as Init
			Gain	MTN		Init: ±2 dB between 0.1 and 1.0 Hz, ±4 dB between 1.0 and 3.0 Hz Rec: Same as Init	Init: ±2 dB between 0.1 and 1.0 Hz, ±4 dB between 1.0 and 3.0 Hz Rec: Same as Init
3.b	Leg balance	N/A	Phase shift (each motion jack compared to a datum jack)	MTN		Init: 0 to 1.5° Rec: Same as Init	Init: 0 to 1.5° Rec: Same as Init
	or						
	Parasitic acceleration	N/A	Acceleration (all axes except vertical)	MTN		Init: ±0.02 g or ±3°/s² (peak) Rec: Same as Init	Init: ±0.02 g or ±3°/s² (peak) Rec: Same as Init

3: Motion System		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
3.c	Turn around	N/A	Deviation of measured heave acceleration from desired acceleration	MTN		Init: ±0.05 g Rec: Same as Init	Init: ±0.05 g Rec: Same as Init
3.d.1	Motion envelope - Pitch	N/A	Displacement	MTN		Init: ±20° Rec: same as Init	Init: ±25° Rec: same as Init
			Velocity	MTN		Init: ±15°/s Rec: same as Init	Init: ±20°/s Rec: same as Init
			Acceleration	MTN		Init: ±75°/s^2 Rec: same as Init	Init: ±100°/s^2 Rec: same as Init
3.d.2	Motion envelope - Roll	N/A	Displacement	MTN		Init: ±20° Rec: same as Init	Init: ±25° Rec: same as Init
			Velocity	MTN		Init: ±15°/s Rec: same as Init	Init: ±20°/s Rec: same as Init
			Acceleration	MTN		Init: ±75°/s^2 Rec: same as Init	Init: ±100°/s^2 Rec: same as Init
3.d.3	Motion envelope - Yaw	N/A	Displacement	MTN		Init: ±25° Rec: same as Init	Init: ±25° Rec: same as Init
			Velocity	MTN		Init: ±15°/s Rec: same as Init	Init: ±20°/s Rec: same as Init
			Acceleration	MTN		Init: ±75°/s^2 Rec: same as Init	Init: ±100°/s^2 Rec: same as Init

3: Motion System		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
3.d.4	Motion envelope - Vertical	N/A	Displacement	MTN		Init: ±22 in Rec: same as Init	Init: ±34 in Rec: same as Init
			Velocity	MTN		Init: ±16 in/s Rec: same as Init	Init: ±24 in/s Rec: same as Init
			Acceleration	MTN		Init: ±0.6 g Rec: same as Init	Init: ±0.8 g Rec: same as Init
3.d.5	Motion envelope - Lateral	N/A	Displacement	MTN		Init: ±26 in Rec: same as Init	Init: ±45 in Rec: same as Init
			Velocity	MTN		Init: ±20 in/s Rec: same as Init	Init: ±28 in/s Rec: same as Init
			Acceleration	MTN		Init: ±0.4 g Rec: same as Init	Init: ±0.6 g Rec: same as Init
3.d.6	Motion envelope - Longitudinal	N/A	Displacement	MTN		Init: ±27 in Rec: same as Init	Init: ±34 in Rec: same as Init
			Velocity	MTN		Init: ±20 in/s Rec: same as Init	Init: ±28 in/s Rec: same as Init
			Acceleration	MTN		Init: ±0.4 g Rec: same as Init	Init: ±0.6 g Rec: same as Init
3.d.7	Motion envelope - Initial rotational acceleration rate	N/A	All axes	MTN		Init: ±225°/s^2/s Rec: same as Init	Init: ±300°/s^2/s Rec: same as Init
3.d.8	Motion envelope - Initial linear	N/A	Vertical	MTN		Init: ±4 g/s Rec: same as Init	Init: ±6 g/s Rec: same as Init

3: Motion System		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
	acceleration rate		Lateral	MTN		Init: ±2 g/s Rec: same as Init	Init: 3 g/s Rec: same as Init
			Longitudinal	MTN		Init: ±2 g/s Rec: same as Init	Init: ±3 g/s Rec: same as Init
3.e	Motion cue repeatability	On ground, and in flight	Actual motion platform linear accelerations	MTN		Init: N/A Rec: ±0.05 g actual motion platform linear accelerations	Init: N/A Rec: ±0.05 g actual motion platform linear accelerations
3.f	Motion cueing performance signature	See Test requirements table below	Correlation between motion cueing and aircraft simulation model	MTN			Init: CT&M Rec: EM

(a) Requirements for all the rotorcraft motion system tests:

3: Motion System	Test requirements
All tests	1. The intent of the tests 3.a motion envelope, 3.b frequency response, 3.c leg balance and 3.d turn around is to demonstrate the performance of the motion system hardware, and to check the integrity of the motion set-up with regard to calibration and wear. These tests are independent of the motion cueing software and shall be considered as robotic tests. 2. Manual tests are not required.

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

3: Motion System		Test requirements
3.a	Frequency response	1. The test shall demonstrate the motion frequency response for an oscillatory input, for each linear and rotational axis. 2. The test shall cover at least frequencies between 0.1 Hz to 3.0 Hz. 3. The test shall be run independent of the motion cueing software and is to be considered as a robotic test. 4. Plots of phase and attenuation shall be plotted against the frequency of the motion movement. 5. The motion movement shall be measured (e.g. by using an accelerometer) and not computed from the leg positions.
3.b	Leg balance or Parasitic acceleration	1. For the leg balance method, the phase shift between a datum jack and any other jack shall be measured using a heave (vertical) signal of 0.5 Hz at ±0.25 g. 2. For the parasitic acceleration method, the acceleration in the other five axes shall be measured using a heave (vertical) signal of 0.5 Hz at ±0.1 g.
3.c	Turn around	1. The test shall demonstrate the motion response during oscillatory manoeuvres does not exhibit excessive noise by driving each motion actuator with a sinusoidal signal and recording the motion movement. 2. The motion base shall be driven sinusoidally in the heave axis through a displacement of 150 mm peak to peak at a frequency of 0.5 Hz. 3. The motion movement shall be measured (e.g. by using an accelerometer) and any deviation compared to the command signal. 4. The test shall be run independent of the motion cueing software and is to be considered as a robotic test.
3.d.7	Motion envelope - initial rotational acceleration rate	1. All rotational axes.
3.e	Motion cue repeatability	1. The test shall demonstrate that the motion system hardware and software, in normal FSTD operating mode, continue to perform as initially qualified, i.e. to demonstrate that the motion system software and motion system hardware have not degraded or changed over time. 2. The characteristics of the test signal shall be set so that the acceleration command reaches 2/3rd of the motion system acceleration envelope for the linear axes, and 2/3rd of the angular velocity envelope for angular axes, as defined in test 3.a. These demands are injected at the point where the aircraft centre of gravity accelerations and velocities would be transformed into the pilot reference point accelerations and velocities prior to entering the motion cueing software. The test signal shall be applied when the system is steady. The tests shall clearly demonstrate the initial motion response to the demands and associated washouts.

<table>
<tr><th colspan="2">3: Motion System</th><th>Test requirements</th></tr>
<tr><td></td><td></td><td>3. Two tests shall be performed, one in an on-ground state and the other in an in-air state. This is to cater for possible differences in motion system gains for the on-ground and in-air conditions. The exact test conditions are to be determined by the applicant for FSTD qualification.
4. Parameters to be plotted are:
a. the acceleration/rate commands;
b. actual linear acceleration measured from accelerometers close to pilot position (the output will comprise accelerations due to both the linear and rotational motion accelerations);
c. motion actuator positions; and
d. the motion system attitude and position (i.e. pitch, roll, yaw, surge, sway, heave)a</td></tr>
<tr><td>3.f</td><td>Motion cueing performance signature</td><td>1. Table below gives the required test cases.
2. A Statement of Justification shall explain the motion movements and give basis for their magnitude and correlation for each test for each axis.
3. Parameters to be plotted:
a. Flight parameters;
b. Motion platform movements on all six axis (i.e. pitch, roll, yaw, heave, sway, and surge);
c. Motion actuator movements; and
d. Correlation of motion cueing with respect to the aircraft simulation model in terms of acceleration and angular rates by overplotting. This plotting shall be done on all the applicable axes for the test (i.e. for the key acceleration and angular cues).

The table below defines the required test cases for an FSTD having each of the aircraft simulation features at fidelity levels G, R or S. If any of those features are at fidelity level N, the tests applicable to the FSTD shall be agreed with the competent authority.
<table>
<tr><th>No.</th><th>Test</th><th>Demonstration method</th><th>Key acceleration and angular cues</th></tr>
<tr><td>1</td><td>Take-off (all engines)</td><td>Test to demonstrate motion cueing for a normal take-off. Inputs and flight parameters as in the test</td><td>• Long term X-axis acceleration due to IAS increase</td></tr>
</table>
</td></tr>
</table>

3: Motion System		Test requirements			
				1.c.1 'Take-off - All engines' .	• Pitch rate for rotorcraft pitch attitude changes • Vertical acceleration (G) due to lift-off trajectory
		2	Hover performance (IGE or OGE)	Test to demonstrate motion cueing for hover either in IGE or OGE. Inputs and flight parameters as in the test 1.d 'Hover performance'.	• Pitch and roll attitude
		3	Control response - longitudinal	Test to demonstrate motion cueing for a small control input. Inputs and flight parameters as in the test 2.c.1 'Control response'.	• Pitch rate for rotorcraft pitch attitude changes
		4	Control response - lateral	Test to demonstrate motion cueing for a small control input. Inputs and flight parameters as in the test 2.d.1.a 'Control response - Lateral'.	• Roll rate for rotorcraft roll attitude changes
		5	Control response - directional	Test to demonstrate motion cueing for a small control input. Inputs and flight parameters as in the test 2.d.1.b 'Control response - Directional'.	• Yaw rate for rotorcraft yaw attitude changes
		6	Autorotational entry	Test to demonstrate motion cueing for autorotation entry. The flight control response to autorotation shall have a 2 seconds delay to demonstrate the motion cueing to the angular movements. The test case may be a footprint test or may use inputs and flight parameters of test 1.i 'Autorotational entry' if they fulfil the above requirement.	• Yaw rate for rotorcraft yaw attitude changes • Roll rate for rotorcraft roll attitude changes • Pitch rate for rotorcraft pitch attitude changes

3: Motion System		Test requirements			
		7	Go-around	Test to demonstrate motion cueing for a go-around. Inputs and flight parameters as in the test 1.j.3 'Balked landing/missed approach'.	• Vertical acceleration (G) due to trajectory
		8	Landing (all engines)	Test to demonstrate motion cueing for normal landing. Inputs and flight parameters as in the test 1.j.1 'All engines landing'.	• Pitch attitude of the aircraft during final approach • Pitch for flare • Heave bumps (G) due to touchdown
		9	Autorotation (landing)	Test to demonstrate motion cueing for autorotation flare. Inputs and flight parameters as in the test 1.j.4 'Autorotational landing with touchdown'.	• Pitch attitude of the aircraft during final approach • Pitch for flare • Vertical acceleration (G) due to trajectory

GM1 FSTD.QTG.H.300 Motion cueing performance signature tests

Refer to GM1 FSTD.QTG.A.300 and GM2 FSTD.QTG.A.300 'Motion Cueing Performance Signature Tests', that are applicable also to rotorcraft.

CS FSTD.QTG.H.305 Characteristic vibrations/buffet - Rotorcraft

This CS provides standards for the objective tests of rotorcraft vibration systems.

3.g: Vibration System		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
3.g.1	Characteristic vibrations - On ground at idle	On ground at idle	Vibration amplitude at frequency 1/rev	VIB			Init: +3 / -6 dB or ±10% of nominal vibration level in cruise flight, and correct trend Rec: Same as Init
			Vibration amplitude at frequency n/rev	VIB			Init: +3 / -6 dB or ±10% of nominal vibration level in cruise flight, and correct trend Rec: Same as Init
3.g.2	Characteristic vibrations - On ground at operating rpm	On ground at operating rpm	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1

3.g: Vibration System		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
3.g.3	Characteristic vibrations - Hover (IGE)	Hover (IGE)	Vibration amplitude at frequency 1/rev	VIB			Same ass 3.g.1
			Vibration amplitude at frequency n/rev	VIB			Same as
3.g.4	Characteristic vibrations - Hover (OGE)	Hover (OGE)	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1
3.g.5	Characteristic vibrations - Normal climb	Normal climb	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1
3.g.6	Characteristic vibrations - Vertical climb	Normal climb	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1

3.g: Vibration System		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1
3.g.7	Characteristic vibrations - Translational lift	Level flight at effective translational lift airspeed	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1
3.g.8	Characteristic vibrations - Cruise speed	Level flight at cruise airspeed	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1
3.g.9	Characteristic vibrations - High speed	High speed	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1
3.g.10	Characteristic vibrations - Descent	Descent	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1

3.g: Vibration System		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1
3.g.11	Characteristic vibrations - Autorotation	Autorotation	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1
3.g.12	Characteristic vibrations - Left steady turn	Left steady turn, cruise	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1
3.g.13	Characteristic vibrations - Right steady turn	Right steady turn, cruise	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1
3.g.14	Characteristic vibrations - Special conditions	See Test requirements table below	Vibration amplitude at frequency 1/rev	VIB			Same as 3.g.1

3.g: Vibration System		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
			Vibration amplitude at frequency n/rev	VIB			Same as 3.g.1
3.g.15	Comparison of vibration amplitudes	On ground and in flight	Overall grms at 1/rev	VIB			Init: Correct trend Rec: Same as Init
			Overall grms at n/rev				Init: Correct trend Rec: Same as Init

(a) Requirements for all the rotorcraft vibration tests:

3.g: Vibration System	Test requirements
All tests	1. Definitions of 1/rev and n/rev: a. 1/rev refers to once per revolution oscillations caused primarily by the aerodynamic forces acting on the main rotor blades as they rotate. b. n/rev refers to the basic 1/rev vibration multiplied by the number of main rotor blades n. If some harmonics (multiple of 1/rev lower than n) are significant, they shall be evaluated with the same tolerances applied as vibrations at n/rev. 2. The comparison between FSTD and validation data can be demonstrated by either of the tolerances: a. +3 / -6 dB between either the FFT or the PSDs of FSTD result and the validation data for the frequency spectrum. The relationship (L) in decibels (dB) between these two fast Fourier transform (FFT) or power spectral densities (PSDs) is calculated at each frequency that is evaluated as: $L = 10log_{10}\left(\frac{FFT_{FSTD}}{FFT_{DATA}}\right)$ or $L = 10log_{10}\left(\frac{PSD_{FSTD}}{PSD_{DATA}}\right)$ The frequency resolution of the Fourier transform depends on the number of frequency lines or bins. This affects the comparison of two different vibrating systems. When comparing the Fourier transform results of validation data and FSTD results, they both shall be processed to the same bandwidth. PSD is more useful here, because the amplitude value is normalised to the frequency bin width. By normalising the result, a more accurate comparison of vibration levels in signals is possible. Because of this, use of PSD for the relationship

3.g: Vibration System	Test requirements
	between validation data and FSTD results is encouraged. b. 10% of the nominal vibration level for cruise flight at each frequency that is evaluated. For all tests conditions: for 1/rev, ±10% of the amplitude of the 1/rev vibration in cruise and level flight, for n/rev, ±10% of the amplitude of the n/rev vibration in cruise and level flight. 3. Parameters to be plotted are acceleration fast Fourier transform (FFT) or power spectral density (PSD) against frequency (FFT in g and PSD in $grms^2/Hz$) for the X, Y and Z axes. 4. The tolerances are applied only at the 1/rev and n/rev frequencies (and at the significant harmonics if applicable). The vibration amplitude 'spikes' shall be present within ±0.5 Hz of the rotorcraft data. 5. If the amplitude on any axis is negligible, its plot may be ignored provided that the statement of justification explains this. 6. The recurrent tests have the same tolerances as the initial evaluation. The recurrent tests are also expected to have very similar results as the MQTG. It is acknowledged that the vibration test results may have some variation when compared to the MQTG due to the random nature of the vibration/buffet and due to the mathematical process used to plot the amplitude against frequency (i.e. Fourier transformation). 7. The tests may give the test conditions and flight parameters as numerical snapshot values, ensuring that flight phases are stable.

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

3.g: Vibration System		Test requirements
3.g.1	Characteristic vibrations - On ground at idle	1. Tests to demonstrate the normal vibration level with rotorcraft on the ground, all engines operating at normal idle power settings.
3.g.2	Characteristic vibrations - On ground at operating rpm	1. Tests to demonstrate the normal vibration level with rotorcraft on the ground, all engines operating at normal flight power settings.
3.g.3	Characteristic vibrations - Hover	1. Test to demonstrate the normal vibration level with rotorcraft in hover condition IGE.

3.g: Vibration System		Test requirements
	(IGE)	
3.g.4	Characteristic vibrations - Hover (OGE)	1. Test to demonstrate the normal vibration level with rotorcraft in hover condition OGE.
3.g.5	Characteristic vibrations - Normal climb	1. Test to demonstrate the normal vibration level with rotorcraft in normal climb at normal climb speed, all engines operating.
3.g.6	Characteristic vibrations - Vertical climb	1. Test to demonstrate the normal vibration level with rotorcraft in vertical climb from a hover condition.
3.g.7	Characteristic vibrations - Translational lift	1. Test to demonstrate the normal vibration level with rotorcraft in forward translational level flight.
3.g.8	Characteristic vibrations - Cruise speed	1. Test to demonstrate the normal vibration level with rotorcraft in flight at normal cruise speed.
3.g.9	Characteristic vibrations - High speed	1. Test to demonstrate the normal vibration level with rotorcraft in flight at high speed (near or at Vne).
3.g.10	Characteristic vibrations - Descent	1. Test to demonstrate the normal vibration level with rotorcraft in normal powered descent at normal speed, all engines operating.
3.g.11	Characteristic vibrations - Autorotation	1. Test to demonstrate the normal vibration level with helicopter in autorotation descent, all engines inoperative (or at least at idle), nominal main rotor RPM and recommended autorotation speed.
3.g.12	Characteristic vibrations - Left	1. Test to demonstrate the normal vibration level with rotorcraft in stabilised turn at various bank angles; at least two conditions are to be demonstrated (for instance for a standard rate of turn and a higher bank angle of around 45° in

3.g: Vibration System		Test requirements
	steady turn	order to demonstrate the effect of rotor disk load on vibration level, if any).
3.g.13	Characteristic vibrations - Right steady turn	1. Test to demonstrate the normal vibration level with rotorcraft in stabilised turn at various bank angles; at least two conditions are to be demonstrated (for instance for a standard rate of turn and a higher bank angle of around 45° in order to demonstrate the effect of rotor disk load on vibration level, if any).
3.g.14	Characteristic vibrations - Special conditions	1. This applies to special steady-state cases identified as particularly significant to the pilot, important in training, or unique to a particular helicopter type or model. This may include the effects of a tandem-rotor helicopter (e.g. translational lift for yawing), icing effect and all relevant vibration cues due to normal and abnormal operations of the rotor and transmission system. 2. The Statement of Justification shall describe the test cases. 3. Steady state tests are acceptable.
3.g.15	Comparison of vibration amplitudes	1. Correct trend refers to a comparison of vibration/buffet amplitudes between different manoeuvres. For example, if the 1/rev vibration amplitude in the rotorcraft is higher during steady state turns than in level flight this increasing trend shall be demonstrated in the FSTD tests. 2. Plots of 1/rev and n/rev overall grms for all the test conditions listed above shall be presented to support evaluation of the correct vibration trend for different test conditions.

GM1 FSTD.QTG.H.305 Vibration harmonics - Rotorcraft

The higher-order vibration harmonics can be caused by a variety of factors, including the interaction of rotor blades with the air and mechanical imbalances. The n represents an integer multiple of the rotational frequency of the rotor. If n = 2, the vibration occurs twice per revolution of the rotor, and so on. For example, if the rotor RPM is 300 and the number of blades is 4, the vibration peaks are expected to occur 300, 600, 900 and 1200 times per minute, or 5, 10, 15 and 20 times per second, i.e. at 5, 10, 15 and 20 Hz.

CS FSTD.QTG.H.405 Visual display system - Rotorcraft

This CS provides standards for the objective tests of rotorcraft FSTD visual display system.

4.a: Visual Scene Quality		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
4.a.1	Continuous cross-cockpit visual field of view	N/A	Horizontal and vertical continuous field of view	VIS	Init: Continuous visual field of view providing each pilot with 150° horizontal and 40° vertical field of view. Horizontal FOV: not less than a total of 146° (including not less than 60° measured either side of the centre of the design eye point). Vertical FOV: not less than a total of 36° measured from the pilot's and co-pilot's eye point. Rec: EM	Init: Continuous visual field of view providing each pilot with 150° horizontal and 60° vertical field of view. Horizontal FOV: not less than a total of 146° (including not less than 60° measured either side of the centre of the design eye point). Vertical FOV: not less than a total of 56° measured from the pilot's and co-pilot's eye point. Rec: EM	Init: Continuous visual field of view providing each pilot with 180° horizontal and 60° vertical field of view. Horizontal FOV: not less than a total of 176° (including not less than 75° measured either side of the centre of the design eye point). Vertical FOV: not less than a total of 56° measured from the pilot's and co-pilot's eye point. Rec: EM

4.a: Visual Scene Quality		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
4.a.2	System geometry	N/A	Discontinuities	VIS	Init: 5° even angular spacing within 1° as measured from either pilot eye-point, and within 1.5° for adjacent squares. Rec: same as Init	Init: 5° even angular spacing within 1° as measured from either pilot eye-point, and within 1.5° for adjacent squares. Rec: same as Init	Init: 5° even angular spacing within 1° as measured from either pilot eye-point, and within 1.5° for adjacent squares. Rec: same as Init
4.a.3	Surface resolution	N/A	Surface resolution	VIS	Init: Not greater than 3 arc minutes Rec: same as Init	Init: Not greater than 3 arc minutes Rec: same as Init	Init: Not greater than 3 arc minutes Rec: same as Init
4.a.4	Lightpoint size	N/A	Lightpoint size	VIS	Init: Not greater than 8 arc minutes. Rec: same as Init	Init: Not greater than 8 arc minutes. Rec: same as Init	Init: Not greater than 6 arc minutes. Rec: same as Init
4.a.5	Surface contrast ratio	N/A	Raster surface contrast ratio	VIS	Init: Not less than 5:1 Rec: same as Init	Init: Not less than 5:1 Rec: same as Init	Init: Not less than 5:1 Rec: same as Init
4.a.6	Lightpoint contrast ratio	N/A	Lightpoint contrast ratio	VIS	Init: Not less than 5:1 Rec: same as Init	Init: Not less than 25:1 Rec: same as Init	Init: Not less than 25:1 Rec: same as Init

4.a: Visual Scene Quality		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
4.a.7	Lightpoint brightness	N/A	Lightpoint brightness	VIS	Init: Not less than 17 cd/m^2 (5 ft-Lamberts) from the display measured at the design eye point Rec: same as Init	Init: Not less than 17 cd/m^2 (5 ft-Lamberts) from the display measured at the design eye point Rec: same as Init	Init: Not less than 20 cd/m^2 (6 ft-Lamberts) from the display measured at the design eye point Rec: same as Init
4.a.8	Surface brightness	N/A	Surface brightness	VIS	Init: Not less than 17 cd/m^2 (5 ft-Lamberts) from the display measured at the design eye point Rec: same as Init	Init: Not less than 17 cd/m^2 (5 ft-Lamberts) from the display measured at the design eye point Rec: same as Init	Init: Not less than 20 cd/m^2 (6 ft-Lamberts) from the display measured at the design eye point Rec: same as Init

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

4.a: Visual Scene Quality		Test requirements
4.a.1	Continuous cross-cockpit visual field of view	1. Field of view shall be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5 squares. Installed alignment shall be confirmed in a Statement of Justification. 2. The minimum horizontal field of view per pilot allows an offset either side of the horizontal field of view if required for the intended use.
4.a.2	System geometry	1. System geometry shall be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5 squares with lightpoints at the intersections. The operator shall demonstrate that the angular spacing of any chosen 5 square and the relative spacing of adjacent squares are within the stated tolerances. The intent of this test is to demonstrate local linearity of the displayed image at either pilot eye- point.

4.a: Visual Scene Quality		Test requirements
4.a.4	Lightpoint size	1. Lightpoint size shall be measured using a test pattern consisting of a centrally located single row of lightpoints reduced in length until modulation is just discernible in each visual channel. 2. A row of 40 lights in the case of 6 arc minutes (30 lights in the case of 8 arc minutes) will form a 4 angle or less.
4.a.5	Surface contrast ratio	1. Surface contrast ratio shall be measured using a raster drawn test pattern filling the entire visual scene (all channels). The test pattern shall consist of black and white squares, no larger than 10 and no smaller than 5° per square with a white square in the centre of each channel. Measurement shall be made on the centre bright square for each channel using a 1 spot photometer. This value shall have a minimum brightness of 7 cd/m2 (2 ft- Lamberts). Measure any adjacent dark squares. The contrast ratio is the bright square value divided by the dark square value. 2. During contrast ratio testing, FSTD aft-cabin and flight deck ambient light levels shall be zero.
4.a.6	Lightpoint contrast ratio	1. Lightpoint contrast ratio shall be measured using a test pattern demonstrating a 1° area filled with lightpoints (i.e. lightpoint modulation just discernible) and shall be compared to the adjacent background. 2. During contrast ratio testing, FSTD aft-cabin and flight deck ambient light levels shall be zero.
4.a.8	Surface brightness	1. Highlight brightness shall be measured by maintaining the full test pattern described in paragraph 5.b.3 above, superimposing a highlight on the centre white square of each channel and measuring the brightness. 2. Lightpoints are not acceptable. 3. Use of calligraphic capabilities to enhance raster brightness is acceptable. 4. For raster only display devices the highlight brightness is measured using a white raster and measuring the average brightness in each channel.

CS FSTD.QTG.H.410 Head-Up Display (HUD)

Refer to CS FSTD.QTG.A.405 'Head-Up Display (HUD)', which is also applicable to rotorcraft. This CS is applicable to installed airborne HUD, and not to helmet-mounted HUD.

CS FSTD.QTG.H.415 Enhanced Flight Vision System (EFVS)

Refer to CS FSTD.QTG.A.410 'Enhanced Flight Vision System (EFVS)', which is also applicable to rotorcraft. This CS is applicable only to EFVS that fall into the following definition: an installed airborne system that provides the flight crew with a real-time display of the external scene topography through the use of imagining sensors, that is integrated with a flight guidance system, and that is implemented on a HUD or equivalent display system.

CS FSTD.QTG.H.420 Night Vision Imaging System (NVIS) - Rotorcraft

Refer to CS FSTD.QTG.A.415 'Night Vision Imaging System (NVIS)', which is also applicable to rotorcraft.

CS FSTD.QTG.H.425 Visual ground segment - Rotorcraft

This CS provides standards for the objective tests of rotorcraft visual ground segment.

4.e: Visual Ground Segment		**Test Conditions**	**Tolerance Parameter**	**Primary Feature(s) Validated**	**Tolerances**		
					G	**R**	**S**
4.e	Visual Ground Segment (VGS)	Trimmed in the landing configuration at 30 m (100 ft) landing gear height above touchdown zone on glide slope at a RVR setting of either 300 m (1000 ft) or 350 m (1200 ft) See also paragraph (a) below for levels G and R	Near end: lights before threshold	VIS	Init: The correct number of approach lights within the computed VGS shall be visible. Rec: same as Init	Init: The correct number of approach lights within the computed VGS shall be visible. Rec: same as Init	Init: The correct number of approach lights within the computed VGS shall be visible. Rec: same as Init
			Far end: lights after the threshold	VIS	Init: ±20% of the computed VGS. Rec: same as Init	Init: ±20% of the computed VGS. Rec: same as Init	Init: ±20% of the computed VGS. Rec: same as Init
			Threshold lights	VIS	Init: The threshold lights computed to be visible shall be visible. Rec: same as Init	Init: The threshold lights computed to be visible shall be visible. Rec: same as Init	Init: The threshold lights computed to be visible shall be visible. Rec: same as Init

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

4.e: Visual Ground Segment		**Test requirements**
4.e	Visual Ground Segment (VGS)	1. This test is designed to assess items impacting the accuracy of the visual scene presented to a pilot at DH on an ILS approach. Those items include: a. RVR;

4.e: Visual Ground Segment		Test requirements
		b. glideslope (G/S) and localiser modelling accuracy (location and slope) for an ILS; and c. for a given weight, configuration and speed representative of a point within the rotorcraft's operational envelope for a normal approach and landing. 2. If non-homogenous fog is used, the vertical variation in horizontal visibility shall be described and be included in the slant range visibility calculation used in the VGS computation. 3. For level G or R, the downward field of view may be limited by the aircraft structure or the visual system display, whichever is less. 4. For level G or R, flight conditions can be either as stated above, or can be replaced by: 'trimmed in the landing configuration at 60 m (200 ft) wheel height above touchdown zone on glide slope at a RVR setting of 500 m (1 700 ft)'.

GM1 FSTD.QTG.H.425 Visual ground segment - Rotorcraft

Refer to GM1 FSTD.QTG.A.420 'Visual Ground Segment - Aeroplanes', which is also applicable to rotorcraft.

CS FSTD.QTG.H.500 Sound systems - Rotorcraft

This CS provides standards for the objective tests of rotorcraft sound systems.

5: Sound Systems		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
5.a.1	Ready for engine start	Ground, ready for engine start	Sound amplitude	SND	Init: Subjective assessment of measured overall SPL Rec: ±3 dB SPL RMS compared to MQTG.	Init: Subjective assessment of 1/3 octave bands Rec: Cannot exceed ±5 dB difference per 1/3 octave band compared to MQTG	Init: within ±5 dB per 1/3 octave band of the aeroplane data Rec: Same as Init
5.a.2	All engines at idle	Ground, all engines at idle, rotor not turning (if applicable)	Sound amplitude	SND		Same as 5.a.1	Same as 5.a.1
5.a.3	All engines at operating rpm	Ground, all engines at operating rpm, rotor turning	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.a.4	Hover	Hover	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.a.5	Climb	En-route climb	Sound amplitude	SND		Same as 5.a.1	Same as 5.a.1
5.a.6	Cruise	Straight cruise and level	Sound amplitude	SND	Same as 5.a.1	Same as 5.a.1	Same as 5.a.1
5.a.7	Final approach	Final approach to landing	Sound amplitude	SND		Same as 5.a.1	Same as 5.a.1
5.b	Reserved						

5: Sound Systems		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances G	Tolerances R	Tolerances S
5.c	Special cases	As defined by applicant for FSTD qualification	Sound amplitude	SND		Same as 5.a.1	Same as 5.a.1
5.d	FSTD background noise	N/A	Sound amplitude	SND	Init: subjective assessment of measured overall SPL. Rec: ±3 dB SPL RMS compared to MQTG	Init: each 1/3 octave band level shall be lower than the reference values in GM1 FSTD.QTG.A.500, figure 10 Rec: ±3 dB per 1/3 octave band compared to the MQTG	Init: each 1/3 octave band level shall be lower than the reference values in GM1 FSTD.QTG.A.500, figure 10 Rec: ±3 dB per 1/3 octave band compared to the MQTG

5: Sound Systems		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
5.e	Frequency response	N/A	Sound amplitude	SND		Init: N/A Rec: cannot exceed ±5 dB on three consecutive bands when compared to the MQTG, and the average of the absolute differences between the MQTG and recurrent results cannot exceed 2 dB	Init: N/A Rec: cannot exceed ±5 dB on three consecutive bands when compared to the MQTG, and the average of the absolute differences between the MQTG and recurrent results cannot exceed 2 dB

(a) Requirements for all the rotorcraft sound systems tests:

5: Sound Systems	Test requirements
All tests	1. For feature SND at fidelity level G: a. All tests in this section may be presented as a single overall SPL level and are only required when the flight deck is fully or partially enclosed (e.g. installed in a dedicated room). 2. For feature SND at fidelity levels R and S: a. All tests in this section shall be presented using an unweighted ⅓ octave band format from band 17 to 42 (50 Hz to 16 kHz). A minimum 20 s average shall be taken at the location corresponding to the reference data set. 3. For feature SND at fidelity level S:

5: Sound Systems	Test requirements
	a. The validation data and FSTD results shall be produced using comparable data analysis techniques. It may be acceptable to have some ⅓ octave bands out of ± 5dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct. 4. The tests may give the test conditions and flight parameters as numerical snapshot values. 5. See GM1 FSTD.QTG.A.500.

(b) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

5: Sound Systems		Test requirements
5.a.1	Ready for engine start	1. Normal conditions prior to engine start. The auxiliary power unit (APU) shall be on if appropriate.
5.a.3	All engines at operating rpm	1. Normal conditions prior to lift-off.
5.a.5	Climb	1. Medium altitude.
5.a.6	Cruise	1. Normal cruise configuration.
5.c	Special cases	1. Special cases identified as particularly significant to the pilot, important in training, or unique to a particular rotorcraft type or variant.
5.d	FSTD background noise	1. The simulated sound will be evaluated to ensure that the background noise does not interfere with training. 2. See GM1 FSTD.QTG.A.500, para e. 3. The measurements shall be made with the simulation running, the sound muted and a dead flight deck.
5.e	Frequency response	1. The test shall be run at three frequencies (high, mid-range, and low). 2. See GM1 FSTD.QTG.A.500, para g.

GM1 FSTD.QTG.H.500 Sound system assessment - Rotorcraft

Refer to GM1 FSTD.QTG.A.500 Sound System Assessment, which is also applicable to rotorcraft.

CS FSTD.QTG.H.600 Systems integration - Rotorcraft

This CS provides standards for the objective tests of rotorcraft systems integration.

6.a: Systems Integration - Systems Response Time		Test Conditions	Tolerance Parameter	Primary Feature(s) Validated	Tolerances		
					G	R	S
6.a	Transport delay	Pitch, roll, and yaw	Motion system response time	MTN		Init: 150 ms or less after controller movement Rec: same as Init	Init: 100 ms or less after controller movement Rec: same as Init
			Visual system response time	VIS	Init: 200 ms or less after controller movement. Rec: same as Init	Init: 150 ms or less after controller movement. Rec: same as Init	Init: 100 ms or less after controller movement. Rec: same as Init
			Instruments system response time	SYS	Init: 200 ms or less after controller movement. Rec: same as Init	Init: 150 ms or less after controller movement. Rec: same as Init	Init: 100 ms or less after controller movement. Rec: same as Init

(a) Individual Test Requirements: The individual test requirements defined in the table below are applicable to all fidelity levels unless otherwise stated.

6.a: Systems Integration - Systems Response Time		Test requirements
6.a	Transport delay	1. A separate test is required in each axis. 2. The test to determine compliance with these requirements shall include simultaneously recording the output from the pilot’s pitch, roll and yaw controllers, the output from the accelerometer attached to the motion system platform located at an acceptable location near the pilots’ seats, the output signal to the visual system display (including visual system analogue delays) and the output signal to the pilot’s attitude indicator or an equivalent test approved by the competent authority.

6.a: Systems Integration - Systems Response Time		Test requirements
		3. Tolerances are based upon the requirement to support the highest device type employing that fidelity level. 4. Motion onset shall also occur before the end of the scan of the first video field containing different information. It is recommended that it occurs just before the start of the scan of the same video field.

GM1 FSTD.QTG.H.600 Systems integration - Rotorcraft

Refer to GM1 FSTD.QTG.A.600 'Transport delay and latency testing methods - Aeroplanes', which is also applicable to rotorcraft.

SUBPART E – FUNCTIONS AND SUBJECTIVE TESTS

GENERAL

CS FSTD.FST.001 General

This CS provides general requirements for functions and subjective tests.

(a) The basis and criteria for the functions and subjective testing are the general requirements presented in Subpart B. The general requirement tables in Subpart B indicate where verification and validation through functions and subjective testing is required.

(b) Functions and subjective testing is a process that requires pilot expertise to assess the FSTD. The necessity of functions and subjective tests arises from the need to confirm that the simulation has produced a totally integrated and acceptable replication of the aircraft type, variant, group or class as applicable. This testing has multiple objectives such as:

(1) to evaluate that the FSTD complies with the requirements concerning the requested FCS;

(2) to evaluate the FSTD’s capability to perform over a typical training session;

(3) to evaluate the functionalities and systems of the simulated aircraft;

(4) to evaluate the performance and handling on manoeuvres and training tasks on various conditions and configurations;

(5) to evaluate the cueing;

(6) to evaluate the simulated malfunctions or failures;

(7) to evaluate the environmental conditions and settings;

(8) to evaluate the IOS functionalities such as reposition, freeze, slew functions;

(9) to evaluate the integration of the whole FSTD;

(10) to evaluate the items declared in the ESL.

(c) Functions tests are objective tests to verify FSTD’s Aircraft Systems functionalities and systems operations in accordance with aircraft documentation such as flight manuals and certification specifications. The testing shall ensure that the systems functions as expected and that aircraft particular aspects (e.g. automation systems unique to the aircraft) operate as expected.

(d) Subjective tests provide a basis for evaluating the FSTD capability to perform over a typical training period and to verify correct operation, cueing and handling characteristics of the FSTD. While objective tests (see Subpart D) provide validation only on the conditions and configuration they are performed at, and will focus on particular feature of the FCS, the subjective tests are used to test the device in more conditions and configurations to evaluate if the performance and handling and flight controls match their expectations throughout the flight envelope. The testing shall ensure that the different features are all properly integrated, for a complete flight simulation.

(e) The list of applicable functions and subjective tests and the testing results shall be recorded and included in the functions and subjective tests table in the MQTG, the ‘Result’ column shall indicate that the test has been assessed satisfactorily. Any relevant details for the tested item (e.g which runway has been used for testing an approach, used configuration, etc.) shall be added in the dedicated 'Remark' column.

GM1 CS FSTD.FST.001 General

The efficient use of the FSTD in a training environment requires minimization of training interruptions and use of different kinds of resets, freezes, repositions, snapshot recalls, flight plan loads, etc. These capabilities can be divided into five functional categories:

1. Simulation control (e.g. flight freeze, fuel freeze, position freeze)
2. Scenario set-up (e.g. weight change, reposition, environment, internal system status reset)
3. Optimisation (e.g. simulation rate times N, snapshot)
4. Maintenance set-up (e.g. build in test equipment - BITE, fault memory clear)
5. Other functions (e.g. head-up displays, flight management data export)

Testing these capabilities, when implemented, should be part of the functions and subjective testing.

These capabilities must be designed in such a way that they minimise training disruptions (e.g. duration for loading a snapshot, for a reposition, possible reset of a particular system after the use of a malfunction, etc.).

ARINC documents 610, 610A, 610B and 610C give guidance to support compliance and building of these capabilities.

CS FSTD.FST.005 Testing methods

This CS defines the testing methods for function and subjective tests.

(a) The organisation requesting qualification of an FSTD shall perform functions and subjective tests to ensure that the device complies with the general requirements in Subpart B for each feature and its associated fidelity level for the requested FCS.

(b) Adequate replication of Aircraft Systems with respect to the desired fidelity level shall be checked at each flight crew member position. All systems functions shall be assessed for normal and, where appropriate, alternate or backup operations.

(c) Handling qualities, performance and FSTD systems operation as they pertain to the actual aircraft or class or group of aircraft, as well as FSTD cueing (e.g. visual and motion cueing) and other supporting systems (e.g. IOS), shall be subjectively assessed.

(d) Normal, abnormal, and emergency procedures associated with a flight phase shall be assessed during the evaluation of manoeuvres or events within that flight phase. The effects of the selected malfunctions shall be sufficient to allow pilots to follow the aircraft-related procedures, normally contained in the pilot checklists or quick reference handbook (QRH). Systems in CS FSTD.FST.100 are listed separately under 'any flight phase' to assure appropriate attention to systems checks in any flight phase.

(e) Functions tests, performance and handling assessments shall be run in a logical flight sequence.

(f) During the Functions and subjective tests, the organisation requesting qualification of an FSTD shall ensure that the FSTD can be used for a typical flight duration without repositioning, freezes or resets, thereby permitting proof of reliability.

(g) For Generic aircraft features, the FSTD does not have to simulate a certain aircraft but a class or group of aircraft. Consequently, the Aircraft Systems simulation may resemble multiple aircraft. The functions and subjective testing shall evaluate and demonstrate if each system alone and the integrated flight deck operation are acceptable to the pilot and if the result of simulation is characteristic of the class or group or aircraft and would be acceptable in real aircraft. The same applies for performance and handling.

(h) The system operation shall be checked for pilot actions and configurations that may reasonably be used by the pilot, even if they would not be in accordance with normal procedures. The purpose is to ensure that the simulation would not contribute to negative transfer of training.

(i) Functions and subjective testing shall also be performed for any additional or alternate engine types, thrust rating or avionics configurations applicable.

GM1 CS FSTD.FST.005 Testing methods

(a) The FCS may have features with different fidelity levels. It is important that the organisation and the individuals testing the FSTD understand the applicable general requirements for the requested FCS. The general requirements indicate what is expected from the simulation. Each feature must be assessed and tested to ensure that the device complies with the general requirements for that feature. But also the interaction and integration of the features must be assessed for every functions and subjective test item.

(b) Functions and subjective testing should cover each test item in detail and for different conditions and flight phases. Examples of this:

(1) Evaluation of an aircraft system malfunction should begin by evaluating if the indications (e.g. master caution and a message) are as expected (e.g. as presented in the aircraft flight manual). Then it should be evaluated if the malfunction leads to the expected consequences (e.g. a generator failure typically leads to redistribution of electrical power, change in the load of operating generators, etc.). The malfunction may have different implications (e.g. cruise vs. final of autoland) due to inhibit functions and therefore the different flight phases should be evaluated.

(2) Subjective evaluation of flight characteristics should cover different environmental conditions (e.g. altitude, winds, QNH, visibility, etc.) and aircraft configurations (e.g. clean, flaps, gear, weight, center of gravity, one or more engines inoperative, etc.) within the flight envelope to ensure that the simulation supports positive training. For example, evaluation of autopilot operations should cover a variety of conditions and configurations. And similarly, evaluation of any manual flying characteristics should cover a variety of conditions and configurations. While it is not possible to cover every single combination of conditions and configurations, the evaluation should adequately and systematically sample them to demonstrate that the simulation does not have unexpected results. The documentation should record the evaluated conditions and configurations.

CS FSTD.FST.010 Table of applicable Functions and Subjective Tests

This CS defines the procedure to be used for the determination of the functions and subjective tests applicable to an FSTD.

(a) The organisation requesting qualification of an FSTD shall prepare a functions and subjective testing table applicable for the FSTD. The table shall include all applicable test items to demonstrate compliance with Subpart B.

(b) For any FSTD, the organisation requesting qualification of an FSTD shall prepare a table of functions and subjective tests by the following steps:

(1) Start with the tables in CS FSTD.FST.020 and CS FSTD.FST.030;

(2) Remove the tests that are not applicable for the simulated aircraft or for the requested FCS;

(3) Expand the list of tests to cover all the applicable general requirements in Subpart B for the requested FCS;

(4) Expand the list of tests to cover the Aircraft Systems operation;

(5) If applicable, expand the list for additional features and capabilities (CS FSTD.QB.017) of the FSTD;

(6) If applicable, expand the list of tests to cover the training areas of specific emphasis (TASE) as applicable to the simulated aircraft and presented in the Operational Suitability Data (OSD) Report; and

(7) If applicable, add any items covered by Special Conditions.

(c) If the FSTD has a missing function or capability based on the simulated aircraft and FCS, a rationale shall be provided.

GM1 CS FSTD.FST.010 Table of applicable Functions and Subjective Tests

(a) The functions and subjective testing must consider all the features simultaneously - the features can't be isolated. For each test item, the testing must evaluate the integrated FSTD, i.e. the device as a whole and all the features at the same time. The tables in CS FSTD.FST.020 and CS FSTD.FST.030 show separate test items for the cueing features (sound, vibration, motion and visual) for levels G, R and S. While these cueing features are presented as separate titles among the table, the cueing must be evaluated for every test item, for a complete flight simulation. Consequently, the cueing features in the table are a summary of items to be evaluated together with all the other test items. Because of this, the sound, vibration, motion and visual cueing features in CS FSTD.FST.020 and CS FSTD.FST.030 are separated for fidelity levels G, R and S. Other test items have not been separated for different fidelity levels, because they depend on all the features. It is important to understand the criteria and expectations for each test when the features are at mixed levels (i.e. not all at the same level but a mixture of N, G, R and S).

(b) The organisation requesting qualification of an FSTD must use the tables in CS FSTD.FST.020 and CS FSTD.FST.030 only as a starting point in preparing the customised table of functions and subjective testing for the individual FSTD in question.

(c) The general requirements (see Subpart B) of the cueing features and for miscellaneous general requirements (see CS FSTD.QB.115) are not repeated in the tables in CS FSTD.FST.020 and CS FSTD.FST.030. The general requirements for the cueing features must be included in the list of functions and subjective tests. The tables in CS FSTD.FST.020 and CS FSTD.FST.030 have references to these applicable general requirements.

(d) The tables in CS FSTD.FST.020 and CS FSTD.FST.030 are not exhaustive and must be customised to the FSTD and its FCS. Items in the tables may not be applicable for the FSTD and FCS. The final functions and subjective testing list prepared by the organisation requesting qualification of an FSTD must reflect the capabilities of the device. It is not necessary to include tests that don't apply to the FSTD.

(e) In accordance with CS FSTD.FST.010, any additional features or capabilities must be covered by the functions and subjective testing. For example, if a rotorcraft FSTD has a hoist system installed, it must be covered in the testing (see CS FSTD.QB.017). Any additional systems or capabilities must be checked to ensure that they do not contribute to negative training.

(f) Examples on cases where functions and subjective test items of CS FSTD.FST.020 and CS FSTD.FST.030 are not applicable:

(1) If the Motion Cueing feature is at level N, then the motion testing is not applicable.

(2) If the FSTD does not have flight control hardware (i.e. Flight Control Forces And Hardware feature is at fidelity level N), then the items requiring manual flying are not applicable.

(3) If the FSTD simulates a single-engine aircraft, then the items applicable only to multi-engine aircraft are not applicable.

(4) If the FSTD does not have an autopilot, then items related to the use of autopilot are not applicable.

(5) If the FSTD is not equipped with a TCAS system, then TCAS tests are not applicable.

(6) If the installed avionics do not support 3D RNP approaches, then tests involving this type of approach are not applicable.

(7) If the FSTD does not have the applicable equipment for CAT III approaches, then tests involving this type of approach are not applicable.

(8) If the FSTD has the Atmosphere And Weather feature at a level that does not require windshear simulation, then windshear tests are not applicable.

FUNCTIONS AND SUBJECTIVE TESTS FOR AEROPLANES

CS FSTD.FST.020 Table of Functions and Subjective Tests for aeroplane FSTDs

Table 1 below presents a table of functions and subjective tests for aeroplane FSTDs to be further modified in accordance with CS FSTD.FST.010.

Table 1.

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)
1	**FLIGHT DECK LAYOUT AND STRUCTURE AND AIRCRAFT SYSTEMS OPERATION**
	● The hardware and system functions must be checked to comply with the general requirements for the FCS. The systems must be checked to comply with the information in the ESL in all flight phases.
2	**PREPARATION FOR FLIGHT**
	● Check the functionality of all switches, indicators, systems, and equipment at all crew members' and instructors' stations.
3	**SURFACE OPERATIONS (PRE-FLIGHT)**
3.a	Engine start:
	● Normal start ● Alternate start procedures ● Abnormal starts and shutdowns (hot start, hung start, tailpipe fire, etc.)
3.b	Taxi:
	● Pushback/powerback ● Thrust response ● Power lever friction ● Ground handling ● Nosewheel scuffing ● Taxi aids (e.g. taxi camera, moving map) ● Low-visibility taxi route (signage, lighting, markings, etc.)
3.c	Brake operation:
	● Brake operation (normal, automatic and alternate/emergency) ● Brake fade
4	**TAKE-OFF** Note: Only those take-off tests relevant to the type or class of aeroplane being simulated must be selected from the following list, where tests must be made with limiting wind velocities, windshear and with relevant system failures.
4.a	Normal:

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)
	● Aeroplane/engine parameter relationships including run-up ● Nose-wheel and rudder steering ● Crosswind: o Crosswind (maximum demonstrated) o Gusting crosswind ● Special performance: o Reduced V1 o Maximum engine de-rate o Soft surface o Short field/short take-off and landing (STOL) operations o Obstacle (performance over visual obstacle) ● Low-visibility take-off ● Landing gear, wing flap leading edge device operation ● Contaminated runway operation
4.b	Abnormal/emergency:
	● Rejected take-off ● Rejected take-off special performance (e.g. reduced V1, max engine de-rate, soft field, short take-off and landing (STOL) operations, etc.) ● Rejected take-off with contaminated runway ● Take-off with a propulsion system malfunction of the most critical engine (allowing an analysis of causes, symptoms, recognition, and the effects on aeroplane performance and handling) at the following points: o Prior to V1 (decision speed); o Between V1 and Vr (rotation speed); and o Between Vr and 500 ft above ground level o after gear-up during climb out ● Flight control system failures, reconfiguration modes, manual reversion and associated handling
5	**CLIMB**
	● Normal ● One or more engines inoperative ● Approach climb in icing (for aeroplanes with icing accountability)
6	**CRUISE**
6.a	Performance characteristics (speed versus power, configuration, and attitude):
	● Straight and level flight ● Change of airspeed ● High-altitude handling ● High-Mach-number handling (Mach tuck, Mach buffet) and recovery (trim change) ● Overspeed warning (in excess of VMO or MMO) ● High-IAS handling
6.b	Manoeuvres:

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)
	● High angle of attack: ○ 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. ○ 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. ● Slow flight ● Upset prevention and recovery manoeuvre within the FSTD validation envelope. ● Flight envelope protection (high angle of attack, bank limit, overspeed, etc.) ● Turns with/without speed brake/spoilers deployed ● Normal and standard rate turns ● Steep turns ● Performance turn ● In-flight engine shutdown and restart (assisted and windmill) ● Manoeuvring with one or more engines inoperative, as appropriate ● Flight characteristics of the particular aircraft (e.g. direct lift control) ● Flight control system failures, reconfiguration modes, manual reversion and associated handling ● Gliding to a forced landing ● Visual resolution and FSTD handling and performance for the following: ○ Terrain accuracy for forced landing area selection ○ Terrain accuracy for VFR navigation
7	**DESCENT**
	● Normal rate ● Maximum rate/emergency (clean and with speedbrake, etc.) ● With autopilot ● Flight control system failures, reconfiguration modes, manual reversion and associated handling
8	**INSTRUMENT APPROACHES OPERATIONS** Only those instrument approach and landing tests relevant to the aeroplane type or class/group being simulated must be selected from the following list. The tests must be conducted both under calm winds and also with limiting wind velocities, windshear (except for CAT II and CAT III precision approaches) and with relevant system failures. The list of functions and subjective testing must contain all the types of approaches defined in the ESL and as applicable to the simulated aircraft, such as: ● 2D/3D approach operations ● All engine operative / one or more engine(s) inoperative ● Autocoupled approach with/without AT ● Manual approach with/without FD/AP/AT ● Autoland ● HUD/EFVS ● Different weather settings including the weather minimas ● With/without windshear The FSTD must be tested for all the listed types of approach with applicable aircraft configurations and flight conditions.

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)
8.a	3D operations on precision approach procedures:
	● CAT I published approaches (all types): ○ Manual approach with/without flight director including landing ○ Autopilot/autothrottle coupled approach and manual landing ○ Autopilot/autothrottle coupled approach, engine(s) inoperative ○ Manual approach, engine(s) Inoperative ○ HUD/EFVS ● CAT II published approaches: ○ Autopilot/autothrottle coupled approach to DH and landing (manual and autoland) ○ Autopilot/autothrottle coupled approach with one-engine-inoperative approach to DH and go-around (manual and autopilot) ○ HUD/EFVS ● CAT III published approaches: ○ Autopilot/autothrottle coupled approach to DH and landing and rollout (manual and autoland) ○ Autopilot/autothrottle coupled approach to DH and G/A (manual and autopilot) ○ Autopilot/autothrottle coupled approach to land and rollout (if applicable) guidance with one engine inoperative (manual and autoland) ○ Autopilot/autothrottle coupled approach to DH and G/A with one engine inoperative (manual and autopilot) ○ HUD/EFVS ● Autopilot/autothrottle coupled approach (to a landing or to a go-around): ○ With generator failure ○ With maximum tailwind component certified or authorised ○ With 10 kt tailwind ○ With maximum crosswind component certified or authorised ○ With 10 kt crosswind ● PAR approach, all engine(s) operating and with one or more engine(s) inoperative ● MLS, GBAS, all engine(s) operating and with one or more engine(s) inoperative
8.b	2D and 3D operations on non-precision approach procedures: Note: If standard operating procedures are to use autopilot for non-precision approaches, then these must be evaluated.
	● Surveillance radar approach, all engine(s) operating and with one or more engine(s) inoperative ● NDB approach (with and without CDFA), all engine(s) operating and with one or more engine(s) inoperative ● VOR, VOR/DME, VOR/TACAN approach (with and without CDFA), all engines(s) operating and with one or more engine(s) inoperative ● RNP APCH approach procedures (with and without CDFA) — localiser performance (LP) and lateral navigation (LNAV) minima (at nominal and minimum authorised temperatures), all engine(s) operating and with one or more engine(s) inoperative ● ILS localiser only (LOC), and ILS localiser back course (LOC-BC) approaches (with and without CDFA), all engine(s) operating and with one or more engine(s) inoperative ● ILS offset localiser approach, all engine(s) operating and with one or more engine(s) inoperative
8.c	3D operations on approach procedures with vertical guidance (APV), e.g. SBAS, flight path vector:

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)
	● RNP APCH Baro VNAV approach procedures (LNAV/VNAV minima), all engine(s) operating and with one or more engine(s) inoperative ● RNP APCH approach procedures based on SBAS (LPV minima), all engine(s) operating and with one or more engine(s) inoperative ● Loss of SBAS signal during approach
8.d	RNP AR APCH:
	● RNP AR APCH approach procedures with Baro-VNAV (RNP 0.3-0.1 minima), all engine(s) operating and with one or more engine(s) inoperative
9	**VISUAL APPROACHES (SEGMENT) AND LANDINGS**
	● Manoeuvring, normal approach and landing all engines operating with and without visual and navigational approach aid guidance ● Approach and landing with one or more engines inoperative ● Operation of landing gear, flap/slats and speed brakes (normal and abnormal) ● Approach and landing with crosswind: o Max. Demonstrated o Gusting ● Approach and landing with flight control system failures, reconfiguration modes, manual reversion and associated handling: ● Approach and landing with trim malfunctions: o longitudinal trim malfunction o lateral-directional trim malfunction ● Approach and landing with standby (minimum) electrical/hydraulic power ● Approach and landing from circling conditions (circling approach) Note: For this test, the visual field of view (see CS FSTD.QB.111) shall be at least 180° horizontally to enable maintaining visual contact with the airport during the whole circling procedure after descending below the minimum descent altitude (MDA). In addition, the Operating Sites And Terrain feature shall be as a minimum on the Representative level (see CS FSTD.QB.114) to enable adequate visual contents in the visual image. Any associated hazard lights or any other visual aids for use as part of the published circling procedure must be included in the correct position(s) and be of the appropriate colour(s), directionality and behaviour. ● Approach and landing from a visual traffic pattern ● Approach and landing from a non-precision approach ● Approach and landing from a precision approach ● Approach and landing from published visual approach (including those that use PBN)
10	**MISSED APPROACH**
	● All engines operating, manual and autopilot ● One or more engine(s) inoperative, manual and autopilot ● Rejected landing ● With auto-flight, flight control system failures, reconfiguration modes and manual reversion
11	**SURFACE OPERATIONS (LANDING, AFTER LANDING, AND POST-FLIGHT)**
11.a	Landing roll and taxi:

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)

	• Spoiler operation
	• Reverse thrust operation
	• Directional control and ground handling, both with and without reverse thrust
	• Reduction of rudder effectiveness with increased reverse thrust (rear pod-mounted engines.)
	• Brake and anti-skid operation:
	  o Brake and anti-skid operation with dry, wet, icy, patchy wet, patchy ice, wet on rubber residue in touchdown zone conditions
	  o Brake and anti-skid operation with dry and wet conditions
	  o Brake operation with dry conditions
	  o Auto-braking system operation where applicable
	• HUD/EFVS

11.b	Engine shutdown and parking:
	• Engine and systems operation • Parking brake operation
12	**ANY FLIGHT PHASE**
12.a	Aeroplane and powerplant systems operation:
	• Air conditioning and pressurisation (environmental control system) • De-icing/anti-icing • Auxiliary powerplant/auxiliary power unit (APU) • Communications • Electrical • Fire and smoke detection and suppression • Flight controls (primary and secondary) • Fuel and oil • Hydraulic • Pneumatic • Landing gear • Oxygen • Powerplant • Airborne radar • Autopilot and flight director • Terrain awareness warning systems and collision avoidance systems (e.g. TAWS, EGPWS, GPWS, TCAS) • Flight control computers including stability and control augmentation • Flight display systems • Flight management computers • Head-up guidance, head-up displays (including EFVS if appropriate) • Navigation systems • Stall warning/avoidance • Windshear avoidance/recovery guidance equipment. • Flight envelope protections • Electronic flight bag • Automatic checklists (normal, abnormal, emergency and deferred procedures) • Runway alerting and advisory systems
12.b	Airborne procedures:

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)			

	● Holding (conventional and RNAV)
	● Air hazard avoidance (traffic, weather, including visual correlation)
	● Windshear
	  ○ Prior to take-off rotation
	  ○ At lift-off
	  ○ During initial climb
	  ○ On final approach, below 150 m (500 ft) AGL
	● Effects of airframe ice			

13	**VISUAL CUEING** The requirements on the visual image as specified must be included in the list of functions and subjective tests: (1) CS FSTD.QB.111 for the applicable fidelity level of the Visual Cueing feature; (2) CS FSTD.QB.113 for the applicable fidelity level of the Atmosphere And Weather feature; and (3) CS FSTD.QB.114 for the applicable fidelity level of the Operating Sites And Terrain feature. The following amends those requirements. Not all elements described in this section need to be found in a single airport/landing area scene. However, all of the elements described in this section must be found throughout a combination of the simulated airport models.			
		FEATURE FIDELITY LEVEL		
		G	**R**	**S**
13.a	Runways and Taxiways			
	The airport runways and taxiways.			✓
	Representative runways and taxiways.		✓	
	Generic runways and taxiways.	✓		
	If appropriate to the airport, two parallel runways and one crossing runway displayed simultaneously; at least two runways must be capable of being lit simultaneously.			✓
	Runway threshold elevations and locations must be modelled to provide correlation with aeroplane systems (e.g. compass, altimeter, GNSS, HUD).	✓	✓	✓
	Slopes in runways, taxiways and ramp areas must not cause distracting or unrealistic effects, including pilot eyepoint height variation.			✓
13.b	Runway surface and markings for each 'in-use' runway must include the following, if appropriate:			
	Threshold markings	✓	✓	✓
	Runway numbers	✓	✓	✓
	Touchdown zone markings		✓	✓
	Fixed distance markings		✓	✓
	Edge markings		✓	✓
	Centre line markings	✓	✓	✓
	Distance remaining signs			✓

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)			
	Signs at intersecting runways and taxiways			√
	Windsock that gives appropriate wind cues	√	√	√
13.c	Runway lighting of appropriate colours, directionality, behaviour and spacing for each 'in-use' runway including the following, if appropriate:			
	Threshold lights	√	√	√
	Edge lights	√	√	√
	End lights	√	√	√
	Centre line lights	√	√	√
	Touchdown zone lights	√	√	√
	Lead-off lights			√
	Appropriate visual landing aid(s) for that runway	√	√	√
	Appropriate approach lighting system for that runway	√	√	√
13.d	Taxiway surface and markings (associated with each 'in-use' runway) must include the following, if appropriate:			
	Edge markings	√	√	√
	Centre line markings	√	√	√
	Runway holding position markings	√	√	√
	ILS critical area markings.			√
	All taxiway markings, lighting and signage to taxi, as a minimum, from a designated parking position to a designated runway and return, after landing on the designated runway, to a designated parking position; a low-visibility taxi route (e.g. surface movement guidance control system, follow-me truck, daylight taxi lights) must also be demonstrated for operations authorised in low visibility. The designated runway and taxi routing must be consistent with that airport for operations in low visibility.			√
13.e	Taxiway lighting of appropriate colours, directionality, behaviour and spacing (associated with each 'in-use' runway) must include the following, if appropriate:			
	Edge lights	√	√	√
	Centre line lights	√	√	√
	Runway holding position and ILS critical area lights	√	√	√
13.f	Visual Model Correlation:			
	The airport model must be properly aligned with the navigational aids that are associated with operations at the runway 'in-use'	√	√	√
	The simulation of runway contaminants must be correlated with the displayed runway surface and lighting.			√
13.g	Airport buildings, structures and lighting:			
	The airport buildings, structures and lighting			√
	Representative airport buildings, structures and lighting.		√	
	Generic airport buildings, structures and lighting.	√		
	At least one useable gate, set at the appropriate height (required only for aeroplanes that typically operate from terminal gates).			√
	Moving and static airport clutter (e.g. other aeroplanes, power carts, tugs, fuel trucks, additional gates).		√	√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)			
	Gate/apron markings (e.g. hazard markings, lead-in lines, gate numbering), lighting and gate docking aids or a marshaller.			✓
13.h	Terrain and obstacles:			
	Terrain and obstacles within 46 km (25 NM) of the reference airport.			✓
	Representative depiction of terrain and obstacles within 46 km (25 NM) of the reference airport.		✓	
13.i	Significant, identifiable natural and cultural features and moving airborne traffic:			
	Significant, identifiable natural and cultural features within 46 km (25 NM) of the reference airport. Note: This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only provide a reasonable facsimile of runway orientation.			✓
	Representative depiction of significant and identifiable natural and cultural features within 46 km (25 NM) of the reference airport. Note: This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only provide a reasonable facsimile of runway orientation.		✓	
	Moving airborne traffic (including the capability to present air hazards, e.g. airborne traffic on a possible collision course).		✓	✓
13.j	Visual scene management:			
	Airport runway, approach and taxiway lighting and cultural feature lighting intensity for any approach must be capable of being set to six different intensities (0 to 5); all visual scene light points must fade into view appropriately.			✓
	Airport runway, approach and taxiway lighting and cultural feature lighting intensity for any approach must be set at an intensity representative of that used in training for the visibility set; all visual scene light points must fade into view appropriately.	✓	✓	
	The directionality of strobe lights, approach lights, runway edge lights, visual landing aids, runway centre line lights, threshold lights and touchdown zone lights on the runway of intended landing must be realistically replicated.			✓
13.k	Visual feature recognition: Note: The following are the minimum distances at which runway features must be visible. Distances are measured from runway threshold to an aeroplane aligned with the runway on an extended 3° glide slope in suitable simulated meteorological conditions. For circling approaches, all tests below apply both to the runway used for the initial approach and to the runway of intended landing.			
	Runway definition, strobe lights, approach lights and runway edge white lights from 8 km (5 sm) of the runway threshold.	✓	✓	✓
13.l	Visual approach aids lights and runway markings:			
	Visual approach aids lights from 8 km (5 sm) of the runway threshold.			✓

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)			
	Visual approach aids lights from 4.8 km (3 sm) of the runway threshold.	√	√	
	Runway centre line lights and taxiway definition from 4.8 km (3 sm)	√	√	√
	Threshold lights and touchdown zone lights from 3.2 km (2 sm).	√	√	√
	Runway markings within range of landing lights for night scenes; as required by the surface resolution test on day scenes.			√
	For circling approaches, the runway of intended landing and associated lighting must fade into view in a non-distracting manner.		√	√
13.m	Selectable airport visual scene capability for:			
	Night	√	√	√
	Twilight	√	√	√
	Day	√	√	√
	Dynamic effects — the capability to present multiple ground and air hazards such as another aeroplane crossing the active runway or converging airborne traffic; hazards must be selectable via controls at the instructor station.		√	√
	Illusions — operational visual scenes which portray physical relationships known to cause landing illusions, for example short runways, landing approaches over water, uphill or downhill runways, rising terrain on the approach path and unique topographic features. Note: Illusions may be demonstrated at a generic airport or at a specific airport.		√	√
13.n	Correlation with aeroplane and associated equipment:			
	Visual cues to relate to actual aeroplane responses	√	√	√
13.o	Visual cues during take-off, approach and landing:			
	Visual cues to assess sink rate and depth perception during landings		√	√
	Visual cueing sufficient to support changes in approach path by using runway perspective. Changes in visual cues during take-off, approach and landing must not distract the pilot.		√	√
	Accurate portrayal of environment relating to aeroplane attitudes.	√	√	√
	The visual scene must correlate with integrated aeroplane systems, where fitted (e.g. terrain, traffic and weather avoidance systems and HUD/EFVS).		√	√
	The effect of rain removal devices must be provided.			√
13.p	Scene quality - Quantization:			
	Surfaces and textural cues must be free from apparent quantization (aliasing).		√	√
	Surfaces and textural cues must not create distracting quantization (aliasing).	√		
	System capable of portraying full colour realistic textural cues.	√	√	√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)			
	The system light points must be free from distracting jitter, smearing or streaking.	✓	✓	✓
	System capable of providing focus effects that simulate rain.		✓	✓
	System capable of providing light point perspective growth.		✓	✓
13.q	Environmental effects:			
	The displayed scene must correspond to the appropriate surface contaminants and include runway lighting reflections for wet, partially obscured lights for snow, or suitable alternative effects.			✓
	Special weather representations which include the sound, motion and visual effects of light, medium and heavy precipitation near a thunderstorm on take-off, approach and landings at and below an altitude of 600 m (2 000 ft) above the airport surface and within a radius of 16 km (10 sm) from the airport.			✓
	One airport with a snow scene to include terrain snow and snow-covered taxiways and runways.			✓
	In-cloud effects such as variable cloud density, speed cues and ambient changes must be provided.			✓
	The effect of multiple cloud layers representing few, scattered, broken and overcast conditions giving partial or complete obstruction of the ground scene.			✓
	Gradual break-out to ambient visibility/RVR, defined as up to 10% of the respective cloud base or top, 6 m (20 ft) ≤ transition layer ≤ 61 m (200 ft); cloud effects must be checked at and below a height of 600 m (2 000 ft) above the airport and within a radius of 16 km (10 sm) from the airport. Transition effects must be complete when the IOS cloud base or top is reached when exiting and start when entering the cloud, i.e. transition effects must occur within the IOS defined cloud layer.			✓
	Visibility and RVR measured in terms of distance. Visibility/RVR must be checked at and below a height of 600 m (2 000 ft) above the airport and within a radius of 16 km (10 sm) from the airport.	✓	✓	✓
	Patchy fog (sometimes referred to as patchy RVR) giving the effect of variable RVR. The lowest RVR must be that selected on the IOS, i.e. variability is only greater than the RVR set on the IOS.		✓	✓
	Effects of fog on airport lighting such as halos and defocus.			✓
	Effect of ownship lighting in reduced visibility, such as reflected glare, to include landing lights, strobes and beacons			✓
	Wind cues to provide the effect of blowing snow or sand across a dry runway or taxiway must be selectable from the instructor station.			✓
14	**VIBRATION AND BUFFET** The requirements specified in CS FSTD.QB.109 for the applicable fidelity level of the Vibration Cueing feature must be included in the list of functions and subjective tests. The following amends those requirements.			
		FEATURE FIDELITY LEVEL		
		G	**R**	**S**

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)			
	Thrust effect with brakes set With the simulated aeroplane set with the brakes on at the take-off point, increase the engine power until buffet is experienced and evaluate its characteristics. Confirm that the buffet increases appropriately with increasing engine thrust.			
	Approach-to-stall buffet and stall buffet (where applicable) 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, 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 must include effects of Nz, as well as Nx and Ny, if relevant.			√
	Mach and manoeuvre buffet With the simulated aeroplane trimmed in 1 g flight while at high altitude, increase the engine power such that the Mach number exceeds the documented value at which Mach buffet is experienced. Check that the buffet begins at the same Mach number as it does in the aeroplane (for the same configuration) and that buffet levels are a reasonable representation of the actual aeroplane. In the case of some aeroplanes, manoeuvre buffet could also be verified for the same effects. Manoeuvre buffet can occur during turning flight at conditions greater than 1 g, particularly at higher altitudes.			√
	Buffet during extension and retraction of landing gear Operate the landing gear. Check that the motion cues of the buffet experienced are characteristic of the actual aeroplane.			√
	Buffet in the air due to flap and spoiler/speed brake extension 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.			√
	Buffet due to atmospheric disturbances			√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)			
	Buffets on the ground due to spoiler/speed brake extension and thrust Perform a normal landing and use ground spoilers and reverse thrust – either individually or in combination with each other – to decelerate the simulated aeroplane. Do not use wheel braking so that only the buffet due to the ground spoilers and thrust reversers is felt.		√	√
15	**MOTION AND MOTION EFFECTS** The requirements specified in CS FSTD.QB.110 for the applicable fidelity level of the Motion Cueing feature must be included in the list of functions and subjective tests. The following amends those requirements. The following motion cueing and effects are required to indicate the threshold at which a flight crew member must recognise an event or situation. Where applicable below, the FSTD pitch, side loading and directional control characteristics must be characteristics to the simulated aircraft.			
		FEATURE FIDELITY LEVEL		
		G	**R**	**S**
	Taxiing effects such as lateral, longitudinal, and directional cues resulting from steering and braking input		√	√
	Effects of runway rumble, oleo deflections, ground speed, uneven runway, running over runway centreline lights and taxiway characteristics After the aeroplane has been pre-set to the take-off position and then released, taxi at various speeds, first with a smooth runway, and note the general characteristics of the simulated runway rumble effects of oleo deflections. Next repeat the manoeuvre with a runway roughness of 50%, then finally with maximum roughness. The associated motion vibrations must be affected by ground speed and runway roughness. Different gross weights may also affect the associated vibrations depending on aeroplane type. The associated motion effects for the above tests must also include an assessment of the effects of centreline lights, surface discontinuities of uneven runways, and various taxiway characteristics.		√	√
	Runway contamination with associated anti-skid	√	√	√
	Bumps associated with the landing gear operation Perform a normal take-off paying special attention to the bumps that could be perceptible due to maximum oleo extension after lift-off. When the landing gear is extended or retracted, motion bumps could be felt when the gear locks into position.	√	√	√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)			
	Touchdown cues for main and nose gear Fly several normal approaches with various rates of descent. Check that the motion cues of the touchdown bump for each descent rate reasonably reflect the actual aeroplane.	√	√	√
	Nose wheel scuffing Taxi the simulated aeroplane at various ground speeds and manipulate the nosewheel steering to cause yaw rates to develop which cause the nosewheel to vibrate against the ground ('scuffing'). Evaluate the speed/nosewheel combination needed to produce scuffing and check that the resultant vibrations reasonably reflect the actual aeroplane.	√	√	√
	Tyre failure dynamics Dependent on aeroplane type, a single tyre failure may not necessarily be noticed by the pilot and therefore there must not be any special motion effect. There may possibly be some sound and/or vibration associated with the actual tyre losing pressure. With a multiple tyre failure selected on the same side the pilot may notice some yawing which must require the use of the rudder to maintain control of the aeroplane.		√	√
	Engine failures, malfunction, engine and airframe structural damage The characteristics of an engine malfunction as stipulated in the malfunction definition document for the particular FSTD must describe the special motion effects felt by the pilot. The associated engine instruments must also vary according to the nature of the malfunction.	√	√	√
	Tail, engine pods/propeller and wing strikes Tail-strikes can be checked by over-rotation of the aeroplane at a speed below Vr whilst performing a take-off. The effects can also be verified during a landing. The motion effect must be felt as a noticeable bump. If the tail strike affects the aeroplane’s angular rates, the cueing provided by the motion system must have an associated effect. Excessive banking of the aeroplane during its take-off/landing roll can cause a pod strike. The motion effect must be felt as a noticeable bump. If the pod strike affects the aeroplane’s angular rates, the cueing provided by the motion system must have an associated effect.		√	√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)			
16	**SOUND SYSTEM** The requirements specified in CS FSTD.QB.108 for the applicable fidelity level of the Sound Cueing feature must be included in the list of functions and subjective tests. The following amends those requirements. The following checks must be performed during a normal flight profile with motion and/or vibration system(s) ON where applicable.			
		FEATURE FIDELITY LEVEL		
		G	**R**	**S**
	Precipitation			✓
	Rain removal equipment			✓
	Significant aeroplane noises perceptible to the pilot during normal operations, such as noises from engine, propeller, flaps, gear, anti-skid, spoiler extension/retraction and thrust reverser to a comparable level of that found in the aeroplane	✓	✓	✓
	Abnormal operations for which there are associated sound cues including, but not limited to, engine malfunctions, landing gear/tyre malfunctions, tail and engine pod/propeller strike and pressurisation malfunctions	✓	✓	✓
	Sound of a crash when the FSTD is landed in excess of limitations	✓	✓	✓
17	**SPECIAL EFFECTS**			
	● Braking dynamics Brake failure dynamics (including anti-skid) and decreased brake efficiency due to high brake temperatures based on aeroplane related data. These representations must be realistic enough to cause pilot identification of the problem and implementation of appropriate procedures. FSTD pitch, side-loading and directional control characteristics must be representative of the aeroplane. ● Effects of airframe and engine icing: See CS FSTD.QB.107.1.ICING. Required only for those aeroplanes authorised for operations in known icing conditions. ● UPRT: See CS FSTD.QB.107.2.UPRT			
18	**INSTRUCTOR OPERATING STATION (IOS)** The requirements specified in CS FSTD.QB.115 must be included in the list of functions and subjective tests. The following amends those requirements. Note: The list below is not exhaustive but is intended to list the sorts of functionalities that must be available to support the intended use, depending on the FSTD and FCS.			
	● Repositions: Note: Repositions must be in-trim at the appropriate speed and configuration for the point. ○ Parking spot ○ Take-off position ○ Approach position (at least three positions at 1.8, 5.5 and 9.3 km (1, 3 and 5 NM) from the runway threshold. ○ Elevated surface position (building top, offshore oil rig, etc.) ○ Confined landing area ○ On a slope			

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)

	• Resets:
	  o System
	  o Temperature
	  o Fluids and agents
	• Weather presets:
	  o Unlimited, CAVOK, VFR, non-precision, APV, precision (CAT I, CAT II, CAT III), EFVS (if appropriate)
	• Visual effects:
	  o Time of day (day, dusk or dawn, night)
	  o Clouds (bases, tops, layers, types, density)
	  o Visibility in kilometres/statute miles
	  o RVR in metres/feet
	  o Special effects (precipitation; thunderstorms; blowing snow; blowing sand; etc.)
	  o Sand/dust/snow/water downwash/recirculation effect ON/OFF
	  o Sea state conditions (0-6)
	• Wind speed and direction:
	  o Surface
	  o Intermediate levels
	  o Typical gradient
	  o Gusts with associated heading and speed variance
	  o Turbulence
	• Temperature — surface
	• Atmospheric pressure (QNH, QFE)
	• Airport/heliport visual effects:
	  o To include active runway or landing area selection
	  o Airport/heliport lighting controls
	  o Airport/heliport preset positions (take-off, approach, oil rig, etc.)
	  o Landing surface conditions (rough, smooth, icy, wet, etc.)
	  o Dynamic effects including ground and airborne traffic
	• Aircraft configuration (fuel, weight, CG, etc., in imperial and metric units):
	  o Gross weight
	  o Fuel loading
	  o Payload
	  o CG (in units appropriate to the aircraft type, e.g. inches, mm)
	  o Aircraft Systems status/control (e.g. rapid navigation system (NAV) alignment (IRS, GPS, AHRS), others)
	  o Ground crew functions (ground power, etc.)
	• Storing and recalling the FMS data unless precluded by installed equipment
	• Ground crew functions (e.g. external power, air, pushback)
	• Plotting and recording (take-off and approach)
	• Aircraft malfunctions (inserting and removing, trigger based on speed, altitude, etc.)
	• Sound controls (ON, OFF and adjustment; indication of when the sound level is set to a value other than the approved level)
	• Motion system (ON, OFF and emergency stop)
	• Control loading system (ON, OFF and emergency stop)
	• Vibration system (ON, OFF and emergency stop)
	• FSTD master/emergency power switch 'OFF'

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (AEROPLANES)

	• Observer seats position/adjustment system and positive restraint system for FSTD with motion (e.g. safety belt, shoulder harness)
	• Communication between the instructor/observer(s) and the flight crew
	• Freezes/resets:
	  ○ Complete simulation freeze
	  ○ Flight/problem freeze
	  ○ Position freeze
	  ○ Fuel freeze
	  ○ Ground speed control
	  ○ Standard atmosphere reset
	  ○ Aircraft system resets (e.g. resetting engine fire bottles after their use)
	
	• Only for aeroplane FSTDs qualified for UPRT:
	UPRT instructor feedback mechanism as described in CS FSTD.QB.115:
	  ○ FSTD validation envelope
	  ○ Flight control inputs
	  ○ Aeroplane operational limits
	  ○ Activation of upset scenarios
	  ○ Operation of the recording mechanism

FUNCTIONS AND SUBJECTIVE TESTS FOR ROTORCRAFT

CS FSTD.FST.030 Table of Functions and Subjective Tests for rotorcraft FSTDs

Table 1 below presents a table of functions and subjective tests for rotorcraft FSTDs to be further modified in accordance with CS FSTD.FST.010.

Table 1.

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)
1	**FLIGHT DECK LAYOUT AND STRUCTURE AND AIRCRAFT SYSTEMS OPERATION**
	● The hardware and system functions must be checked to comply with the general requirements for the FCS: The systems must be checked to comply with the information in the ESL in all flight phases.
2	**PREPARATION FOR FLIGHT**
	● Accomplish a functions check of all switches, indicators, systems, and equipment at all crew members' and instructors' stations and determine that: ○ The flight deck design and functions are according to the fidelity level of the FDK. ○ The ambient lighting provides an even level of illumination and is not distracting to the flight crew members.
3	**SURFACE OPERATIONS (PRE-FLIGHT)**
3.a	APU/Engine start and run-up: Note: After start checks but no before start checks or programming of navigation aids and communication setups.
	● Normal start ● Alternate start procedures ● Abnormal starts and shutdowns (hot start, hung start, fire, etc.) ● Rotor start/engagement and acceleration, disengagement and deceleration ○ Rotor start/engagement and acceleration ○ Rotor disengagement and deceleration (needles split) ○ Ground resonance (if applicable on type) ○ Icy/slippery surface ● After start systems checks (e.g. electrical, hydraulic, flight controls, autopilot, radios, lighting systems)
3.b	Taxi-Ground:
	● Collective lever/cyclic friction setting ● Power required to taxi/cyclic input ● Brakes operation (effectiveness/failure) ● Ground handling ● Water taxi/handling/floats ● Tail/nosewheel lock operation ● Minimum radius turn ● Taxi aids (e.g. taxi camera, moving map) ● Surface contaminants (water, snow, ice, sand, etc.)

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)
	● Surface roughness ● Surface type (hard, soft, etc.)
3.c	Taxi — Hover/air/transit/translational flight
	● Lift-off characteristics with and without wind ● Hover characteristics, engine and flight instruments response (IGE and OGE) Note: Hovering modes must include SAS ON and OFF, height stability ON and OFF, cyclic trim ON and OFF, follow-up trims and automation and protections as applicable to the simulated aircraft. ○ In ground effect (IGE) ○ Out of ground effect (OGE) ○ With and without wind ● Hover power check ○ In ground effect (IGE) ○ Out of ground effect (OGE) ● Hover turns (around a spot, about the nose/tail) ● Anti-torque/directional control effect ● Translating tendency ● No wind/headwind/crosswind/tailwind hover ● Critical azimuth ● Air taxi/transit/translational flight (forward, sideward, rearward)
4	**TAKE-OFF AND DEPARTURE** Note: Only those take-off tests relevant to the type or group of aircraft being simulated must be selected from the following list, where tests must be made with limiting wind velocities, windshear and with relevant system failures.
4.a	Normal:
	● Normal: ○ From ground ● From hover: ○ CAT A and/or performance class 1 (PC1) / performance class 2 (PC2) for all certified profiles ○ CAT B or performance class 3 (PC3) ● Running ● Crosswind/tailwind ● Maximum performance ● Maximum certificated take-off mass ● Instrument (in IMC) ● Confined area ● Slope ● Obstacle clearance ● Elevated heliport/helideck/pinnacle/platform ● Vertical ● High altitude ● Take-off n snow, sand, dust ● Transition into forward flight ● Instrument departure
4.b	Abnormal/emergency procedure during take-off and departure
	● Engine failure ● Rejected take-off/forced landing:

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)
	○ Over land ○ Over water ● CAT A and/or performance class 1 (PC1) / performance class 2 (PC2): ○ Engine failure prior to take-off decision point (TDP) ○ Engine failure at or after take-off decision point (TDP)
5	**CLIMB**
	● Normal ● Obstacle clearance ● Best rate ● Best angle ● Vertical climb ● One (or more) engine(s) inoperative ● Level-off ● CAT A and/or performance class 1 (PC1) / performance class 2 (PC2) operation for all certified profiles with engine failure up to 300 m (1 000 ft) above heliport elevation
6	**CRUISE**
6.a	Performance characteristics and flying qualities:
	● Straight and level flight ● Low speed flight (not below ETL speed) ● Accelerations and decelerations ● High speed vibrations ● High speed warnings ● Turns: ○ Normal ○ Standard rates (rate ½, 1 and 2) ○ Steep (30 and 45° of bank) ○ Flight controls servo actuator transparency effects
6.b	En-route navigation:
	● Terrain accuracy for forced landing area selection ● Terrain accuracy for visual navigation ● Radio navigation ● GNSS navigation (as applicable)
7	**DESCENT AND ARRIVAL**
	● Normal descent ● Maximum rate descent/non-emergency autorotation (VFR and IFR) ● Autorotative descent: ○ Straight-in ○ With turn ○ IMC ○ To landing ○ Power recovery ● Instrument arrival
8	**INSTRUMENT APPROACHES AND LANDING** Note: Only those instrument approach and landing tests relevant to the aircraft type or group of aircraft being simulated must be selected from the following list. The tests

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)
	must be conducted both under calm winds and also with limiting wind velocities and with relevant system failures. The list of functions and subjective testing must contain all the types of approaches defined in the ESL as applicable to the simulated aircraft, such as: • 2D/3D approach operations • All engine operative / one or more engine(s) inoperative • Approach with/without upper modes • Automatic level off • NVG • Different weather settings including the weather minimas The FSTD must be tested for all the listed types of approach with applicable aircraft configurations and flight conditions.
8.a	Precision approach down to decision height/altitude:

	• All engines operating
	• One (or more) engine(s) inoperative
	• Autopilot coupled approach (3, 4 axis)
	• Manual approach with FD guidance
	• Manual approach without FD guidance (raw data)
	• With HUD/EFVS
	• Approach procedures
	  o ILS:
	    ■ CAT I published approaches
	    ■ CAT II published approaches
	  o DGPS/GLS

8.b	Non-precision approach down to MDA/H:

	• All engines operating
	• One (or more) engine(s) inoperative
	• Autopilot coupled approach (3, 4 axis)
	• Manual approach with FD guidance
	• Manual approach without FD guidance (raw data)
	• With HUD/EFVS
	• Approach procedures:
	  o RNAV/RNP/GNSS/RNP APCH, RNP 0.3 APCH, PINS
	  o ILS LLZ (LOC), LLZ back course (or LOC-BC)
	  o ILS offset localizer/SDF (Simplified Directional Facility)
	  o Circling (approach prior to visual circling manoeuvre)
	  o VOR, VOR/DME, TACAN
	  o ARA
	  o NDB

8.c	3D operations on approach procedures with vertical guidance (APV), e.g. SBAS, flight path vector:
	• RNP APCH Baro VNAV approach procedures (LNAV/VNAV minima), all engine(s) operating and with one or more engine(s) inoperative • RNP APCH approach procedures based on SBAS (LPV minima), all engine(s) operating and with one or more engine(s) inoperative • Loss of SBAS signal during approach

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)
8.d	Missed approach (including at MAPt):
	• All engines operating, manual and autopilot coupled • One (or more) engine(s) inoperative, manual and autopilot coupled • With autopilot/stability augmentation system failure
9	**VISUAL APPROACHES (SEGMENT) AND LANDINGS**

	• Normal
	• Steep
	• Shallow
	• Vertical
	• Elevated landing sites/pinnacle/ridgelines/slope
	• Helideck (ship)/rig
	• Confined area
	• Crosswind/tailwind
	• Visual traffic pattern
	• Visual circling to land manoeuvre after an instrument approach
	• Quick stop
	• Forced landing approach
	• Transition to hover
	• With HUD/EFVS
	  ○ Straight-in
	  ○ With turn
	  ○ IMC
	  ○ To landing
	  ○ Power recovery
	• Instrument arrival
	• CAT A or performance class 1 (PC1) / performance class 2 (PC2) operation for all certified profiles from 300 m (1000 ft) above heliport elevation to or after landing decision point (LDP)

9.o	Balked landing:
	• All engines operating • One engine inoperative • Balked rig/deck landing
10	**LANDING TRANSITION / TOUCHDOWN**
	• From a hover • Running • Slope • Surface (hard, soft, water) • Crosswind/tailwind • High altitude • Snow/sand/dust/water spray • Elevated landing sites/pinnacle/ridgelines • Helideck (ship)/rig • From a visual approach • From an instrument approach to minimums and visual final approach thereafter • From autorotation • With anti-torque/directional control malfunction

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)

	• CAT A operation for all certified profiles for performance class 1 (PC1) / performance class 2 (PC2) :
	  ○ Landing with engine failure prior to landing decision point (LDP)
	  ○ Landing with engine failure at or after landing decision point (LDP)

11	**ENGINE SHUTDOWN AND PARKING**
	• Engine and systems operation • Parking brake operation • Rotor disengagement and deceleration • Rotor brake operation • Emergency evacuation
12	**ANY FLIGHT PHASE**
12.a	Aircraft and powerplant systems operation (where fitted) including associated abnormal and emergency procedures:
	• Air conditioning and ventilation system • Autopilot and flight director • Stability and control augmentation system • Communications • Electrical system • Fire and smoke detection and suppression system • Flight controls • Flight control computers • Stabiliser/stabilator • Fuel and oil systems. • Hydraulic system • De-icing/anti-icing system • Landing gear including landing gear operating time and floats deployment • Lighting (internal and external). • Oxygen system • Pneumatic system • Auxiliary engine/auxiliary power unit (APU) • Engine • Transmission systems • Rotor systems • Airborne radar used for weather avoidance, offshore operations and approaches (ARA) • Terrain awareness warning systems and airborne collision avoidance systems (e.g. HTAWS, EGPWS, GPWS, TCAS) • Flight data display systems • Flight instruments system • Flight management systems • Head-up displays (including EFVS, if appropriate) • Navigation systems • Windshear avoidance equipment • Electronic flight bag • Automatic checklists (normal, abnormal and emergency procedures) • Voice activated systems
12.b	Airborne and other miscellaneous procedures:
	• Holding

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)
	• Air hazard avoidance (traffic, weather, including visual correlation) • Mast bumping • Inadvertent entry into IMC • Recovery from unusual attitudes • Windshear/microburst encounters • Airborne weather radar • Engine failure – restart • High altitude operations • Brake and tire failures
12.c	Abnormal and emergency procedures / abnormal and emergency procedures:
	• Stability augmentation malfunction in flight • Autopilot malfunction in flight • Engine fire on ground or in the hover • Engine fire in forward flight • Engine malfunctions • Airframe fire and smoke on ground or in the hover • Airframe fire and smoke in forward flight • Engine failure before CDP/rejected take-off • Engine failure after CDP (multi-engine) • OEI instrument approaches and go-around • OEI instrument approaches and landing • Autorotation to engine off landing • Incipient vortex ring/power settling at altitude • Incipient vortex ring/power settling on approach • Recovery from unusual attitudes • MGB/IGB/TRGB chip detector/oil pressure warning in the hover • MGB/IGB/TRGB chip detector/oil pressure warning in forward flight • Hydraulic failure in the hover • Hydraulic failure in forward flight • Hydraulic jack stall (servo transparency) • Instrumentation/indication failure VFR • Instrumentation/indication failure IFR • DC system failure • AC system failure • Battery failure • Total electrical failure • Fuel transfer failure • Fuel supply malfunction • Landing gear malfunction • Unintended yaw / Loss of tail-rotor (TR) effectiveness • TR drive failure in the hover • TR drive failure in forward flight • TR control failure in the hover • TR control failure in forward flight • Coupled control malfunction • Uncoupled control malfunction • Dynamic rollover • Severe vibration

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	● Ground resonance ● Retreating blade stall ● Rotor and airframe icing ● Engine icing ● Anti-icing system malfunctions ● Ditching ● FADEC failures			
13	**VISUAL CUEING** The requirements on the visual image as specified must be included in the list of functions and subjective tests: (1) CS FSTD.QB.111 for the applicable fidelity level of the Visual Cueing feature; (2) CS FSTD.QB.113 for the applicable fidelity level of the Atmosphere And Weather feature; and (3) CS FSTD.QB.114 for the applicable fidelity level of the Operating Sites And Terrain feature. The following amends those requirements. Not all elements described in this section need to be found in a single airport/landing area scene. However, all of the elements described in this section must be found throughout a combination of the simulated airport models.			
		FEATURE FIDELITY LEVEL		
		G	**R**	**S**
13.a	Landing areas, runways and taxiways:			
	The landing areas, airport runways and taxiways			✓
	Representative landing areas, runways and taxiways		✓	
	Generic landing areas, runways and taxiways	✓		
	If appropriate to the airport, two parallel runways and one crossing runway displayed simultaneously; at least two runways must be capable of being lit simultaneously.			✓
	Rotorcraft landing areas and runway threshold elevations and locations must be modelled to provide correlation with rotorcraft systems (e.g. HUD, GPS, compass, altimeter).	✓	✓	✓
	Slopes in landing areas, runways, taxiways, and ramp areas must not cause distracting or unrealistic effects, including pilot eyepoint height variation.			✓
13.b	Rotorcraft landing area surface, markings and lighting:			
	Landing area surface and markings for each rotorcraft landing area must include the following, if appropriate:			
	● Markings for standard heliport identification ('H' and location), other specific marking such as a hospital pad, aiming point and aiming circle, where appropriate, properly sized, coloured and oriented.		✓	✓
	● TLOF		✓	✓
	● FATO designation markings as appropriate (including design size, 'D' value, weight limitations, etc., where appropriate)		✓	✓
	● Safety areas, OFS and LOS as appropriate		✓	✓

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	● Signs as appropriate for model used		√	√
	● Signs at intersecting runways and taxiways		√	√
	● Windsock that gives appropriate wind cues	√	√	√
	● Windsock lighting.	√	√	√
13.c	Lighting of appropriate colours for the rotorcraft landing area including the following:			
	● Landing direction	√	√	√
	● Raised and flush FATO, TLOF perimeter and flood lighting		√	√
	● Visual approach aids.	√	√	√
	● Approach lighting of appropriate colour.	√	√	√
	Taxiway and movement area and markings associated with the rotorcraft landing area:			
	● Taxiways/taxi routes	√	√	√
	● Aprons		√	√
	Taxiway lighting of appropriate colours, directionality, behaviour and spacing, associated with each pad:			
	● Taxiways/taxi routes	√	√	√
	● Aprons		√	√
13.d	Airport surface, markings and lighting:			
	Runway surface and markings for each 'in-use' runway must include the following, if appropriate:			
	● Threshold markings	√	√	√
	● Runway numbers.	√	√	√
	● Touchdown zone markings		√	√
	● Fixed distance markings		√	√
	● Edge markings		√	√
	● Centre line markings	√	√	√
	● Distance remaining signs		√	√
	● Signs at intersecting runways and taxiways		√	√
	● Windsock that gives appropriate wind cues	√	√	√
	Lighting of appropriate colours for the runway in use including the following:			
	● Threshold lights	√	√	√
	● Edge lights	√	√	√
	● End lights	√	√	√
	● Centre line lights	√	√	√
	● Touchdown zone lights	√	√	√
	● Lead-off lights		√	√
	● Appropriate visual landing aid(s) for that runway		√	√
	● Appropriate approach lighting system for that runway	√	√	√
	● Windsock lighting	√	√	√
	Taxiway surface and markings associated with each 'in-use' runway:			
	● Edge markings		√	√
	● Centre line markings		√	√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	• Runway holding position markings	✓	✓	✓
	• ILS critical area markings		✓	✓
	• All taxiway markings, lighting, and signage to taxi, as a minimum, from a designated parking position to a designated runway and return, after landing on the designated runway, to a designated parking position; a low visibility taxi route (e.g. surface movement guidance control system, follow-me truck, daylight taxi lights) must also be demonstrated for those operations authorized in low visibilities. The designated runway and taxi routing must be consistent with that airport for operations in low visibilities.		✓	✓
	Taxiway lighting of appropriate colours, directionality, behaviour and spacing, associated with each 'in-use' runway:			
	• Edge lights	✓	✓	✓
	• Centre line lights	✓	✓	✓
	• Runway holding position and ILS critical area lights	✓	✓	✓
13.e	Required visual model correlation with other aspects of the airport and landing area environment simulation:			
	The airport or rotorcraft landing area model must be properly aligned with the navigational aids that are associated with operations at the runway 'in-use' or rotorcraft landing area.	✓	✓	✓
	The simulation of runway or rotorcraft landing area contaminants must be correlated with the displayed runway surface and lighting.		✓	✓
13.f	Airport and rotorcraft landing area buildings, structures, objects and lighting:			
	Buildings, structures and lighting:			
	• The airport or rotorcraft landing area buildings, structures, objects and lighting			✓
	• Representative airport or rotorcraft landing area buildings, structures, objects and lighting		✓	
	• Generic airport or rotorcraft landing area buildings, structures, objects and lighting	✓		
	Moving and static clutter (e.g. other rotorcraft and aeroplanes, power carts, tugs, fuel trucks)		✓	✓
	Apron markings (e.g. hazard markings, lead-in lines), lighting and a marshaller			✓
13.g	Terrain and obstacles:			
	Terrain and obstacles within 46 km (25 NM) of the reference airport or rotorcraft landing area with appropriate colours and textures for the simulated area. This includes ground objects of sufficient number, appropriate size and perspective.			✓
	Representative depiction of terrain and obstacles within 18.5 km (10 NM) of the reference airport or landing area with colours and textures, as appropriate.		✓	

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	Depiction of terrain topographical features within 9.25 km (5 NM) of the reference airport or landing area. A limited area flat world is acceptable.	√		
	General terrain characteristics: below 1 500 m (5 000 ft) visual scene with adequate terrain features to permit navigation by sole reference to visual landmarks according to appropriate charts (typically 1:500 000, 1:250 000, 1:100 000 scale mapping). Terrain contouring must be suitably represented.			√
	Buildings, trees or other vertical obstructions in the immediate vicinity of the landing area.		√	√
	Suspended wires in the immediate vicinity of the landing area.		√	√
13.h	Significant, identifiable natural and cultural features and moving airborne traffic:			
	Significant, identifiable natural and cultural features within 46 km (25 NM) of the reference airport or rotorcraft landing area. Note: This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only to provide a reasonable facsimile of runway orientation.			√
	Representative depiction of significant and identifiable natural and cultural features within 18.5 km (10 NM) of the reference airport or rotorcraft landing area. Note: This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only to provide a reasonable facsimile of runway orientation.		√	
	Moving airborne traffic (including the capability to present air hazards – e.g. airborne traffic on a possible collision course).		√	√
13.i	Visual scene management. Note: The following are the minimum distances at which landing areas and runway features must be visible. Distances are measured from the runway threshold or rotorcraft landing area to a rotorcraft aligned with the runway or rotorcraft landing area on an extended 3-degree glide slope in suitable simulated meteorological conditions. For circling approaches, all tests below apply both to the runway used for the initial approach and to the runway of intended landing.			
	All landing area and airport runway, approach and taxiway lighting, and cultural feature lighting intensity for any approach must be capable of being set to six (6) different intensities (0 to 5); all visual scene light-points must fade into view appropriately in accordance with the environmental conditions set in the FSTD. .		√	√
	Airport runway, approach and taxiway lighting, rotorcraft landing area approach lighting and cultural feature lighting intensity for any approach must be set at an intensity representative of that used in training for the visibility set; all visual scene light-points must fade into view appropriately.	√		
	The directionality of strobe lights, approach lights, runway edge lights, visual landing aids, runway centre line lights, threshold	√	√	√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	lights, touchdown zone lights on the runway of intended landing and TLOF or FATO lights must be realistically replicated.			
13.j	Visual feature recognition. Note: The following are the minimum distances at which landing areas and runway features must be visible. Distances are measured from the runway threshold or rotorcraft landing area to a rotorcraft aligned with the runway or rotorcraft landing area on an extended 3-degree glide slope in suitable simulated meteorological conditions. For circling approaches, all tests below apply both to the runway used for the initial approach and to the runway of intended landing.			
	For rotorcraft landing areas:			
	● Heliport definition, strobe lights, approach lights, from 4.8 km (3 sm)	√	√	√
	● Visual approach aids lights (e.g. HAPI) through approach angles up to 12 degrees.	√	√	√
	● Taxiway definition from 3.2 km (2 sm).	√	√	√
	● Markings within range of landing lights for night or dusk and dawn scenes.	√	√	√
	● Markings as required by the surface resolution test on day scenes.		√	√
	● Landing direction lights and raised FATO lights from 1.6 km (1 sm).		√	√
	● Flush mounted FATO lights, TLOF lights, and the lighted windsock from 800 m (0.5 sm).	√	√	√
	● Hover taxiway lighting (yellow/blue/yellow cylinders) from TLOF.	√	√	√
	For runways:			
	● Runway definition, strobe lights, approach lights, and runway edge white lights from 8 km (5 sm) of the runway threshold.	√	√	√
	● Visual approach aids lights (VASIS, PAPI, etc.) from 8 km (5 sm) of the runway threshold.			√
	● Visual approach aids lights (VASIS, PAPI, etc.) from 4.8 km (3 sm) of the runway threshold.	√	√	√
	● Runway centre line lights and taxiway definition from 4.8 km (3 sm).	√	√	√
	● Threshold lights and touchdown zone lights from 3.2 km (2 sm).	√	√	√
	● Runway markings within range of landing lights for night or dusk and dawn scenes.	√	√	√
	● Runway markings as required by the surface resolution test on day scenes.		√	√
	● For circling approaches, the runway of intended landing and associated lighting must fade into view in a non-distracting manner.		√	√
13.k	Selectable airport visual scene capability for:			
	Night	√	√	√
	Dusk or dawn	√	√	√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	Day	√	√	√
	Dynamic effects — the capability to present multiple ground and air hazards, such as an aeroplane or another rotorcraft crossing the active runway or converging airborne traffic, a supply ship in the vicinity of the oil rig when the rotorcraft is on final approach for landing, etc.; hazards must be selectable via controls at the instructor station.		√	√
	Illusions — operational visual scenes which portray physical relationships known to cause landing illusions, for example, short runways, landing approaches over water, uphill or downhill runways, rising terrain on the approach path and unique topographic features. Note: Illusions may be demonstrated at any operating site.			√
13.l	Correlation with rotorcraft and associated equipment:			
	Visual system compatibility with aerodynamic programming	√	√	√
	Visual cues to relate to actual rotorcraft responses	√	√	√
	Visual cues to enable assessing sink rate and depth perception during landing		√	√
	Accurate portrayal of environment relating to rotorcraft attitudes.	√	√	√
13.m	The visual scene must correlate with integrated rotorcraft systems, where fitted (e.g. terrain, traffic and weather avoidance systems and HUD/EFVS):			
	• Weather radar returns must correlate with the visual scene.	√	√	√
	• Radar equipment used for offshore operations (ARA) must provide appropriate returns simulation correlated with the visual scene.		√	√
	• Terrain awareness warning system (e.g. HTAWS, EGPWS, GPWS) must correlate with the visual scene.		√	√
	• Airborne collision avoidance systems (e.g. TCAS) must correlate with the visual scene.		√	√
	The effect of rain removal devices must be provided (i.e. the reduction of rain defocus once activated).		√	√
	The visual effects for each visible, ownship, rotorcraft external light(s) must be provided – taxi, landing and search light lobes including independent operation.	√	√	√
	Dynamic visual representation of rotor blades and tip path including effects of rotor start-up and shutdown as well as orientation of the rotor disc due to pilot control input.		√	√
	Visual representation of rotor blade tip path plane and orientation due to pilot control input.	√		
	The visual system must provide appropriate height and 3-D object collision detection feedback, based on rotorcraft geometry, to support training.	√	√	√
13.n	Scene quality:			
	Quantization:			

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	• Surfaces and textural cues must be free from apparent quantization (aliasing)			√
	• Surfaces and textural cues must not create distracting quantization (aliasing)	√	√	
	System capable of portraying full colour realistic textural cues		√	√
	The system light-points must be free from distracting jitter, smearing or streaking.	√	√	√
	System capable of providing focus effects that simulate rain		√	√
	System capable of providing light-point perspective growth		√	√
	Demonstration of occulting through each channel of the system in an operational scene	√	√	√
13.o	Environmental effects:			
	The displayed scene must correspond to the appropriate surface contaminants and include runway lighting reflections for wet, partially obscured lights for snow, or suitable alternative effects		√	√
	Special weather representations, which include the sound, motion and visual effects of light, medium and heavy precipitation near a thunderstorm on take-off, approach and landings at and below an altitude of 600 m (2 000 ft) above the airport or landing area surface and within a radius of 16 km (10 sm) from the aerodrome		√	√
	One airport or landing area with a snow scene to include terrain snow and snow-covered surfaces		√	√
	In-cloud effects such as variable cloud density, speed cues and ambient changes must be provided		√	√
	The effect of multiple cloud layers representing few, scattered, broken and overcast conditions giving partial or complete obstruction of the ground scene		√	√
	The effect of a cloud layer with adjustable base and top giving complete obstruction of the ground scene	√		
	Gradual breakout to ambient visibility/RVR, defined as up to 10% of the respective cloud base or top, 6.1 m (20 ft) ≤ transition layer ≤ 61 m (200 ft); cloud effects must be checked at and below a height of 600 m (2 000 ft) above the aerodrome or rotorcraft landing area and within a radius of 16 km (10 sm) from the aerodrome or rotorcraft landing area. Transition effects must be complete when the IOS cloud base or top is reached when exiting and start when entering the cloud, i.e. transition effects must occur within the IOS defined cloud layer.		√	√
	Visibility and RVR measured in terms of distance. Visibility/RVR must be checked at and below a height of 600 m (2 000 ft) above the aerodrome or rotorcraft landing area and within a radius of 16 km (10 sm) from the aerodrome or rotorcraft landing area	√	√	√
	Patchy fog (sometimes referred to as patchy RVR) giving the effect of variable RVR. The lowest RVR must be that selected on the IOS, i.e. variability is only greater than the RVR set on the IOS.		√	√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	Effects of fog on aerodrome or rotorcraft landing area lighting such as halos and defocus		√	√
	Effect of ownship lighting in reduced visibility, such as reflected glare, to include landing lights, search lights, strobes, and beacons		√	√
	Wind cues to provide the effect of blowing snow or sand across a dry runway or taxiway or landing area surface must be selectable from the instructor station			√
	The effect of ownship downwash upon the surface (e.g. grass, dirt, water)		√	√
	'Whiteout' or 'brownout' recirculation effects of own rotorcraft's rotor downwash upon various surfaces such as snow, sand, dirt, water and grass including the effects of reduced visibility beginning at a distance above the ground equal to approximately one half the rotor diameter		√	√
	The effects of swell and wind on a 3-dimensional ocean model must be simulated including wind lanes; sea states of 0 to 6 must be provided. Ships and other moving vessels in the ocean must conform to the sea state		√	√
	The effect of trees movement in confined areas			√
	Precipitation effects for rain, hail and snow		√	√
14	**VIBRATION AND BUFFET** The requirements specified in CS FSTD.QB.109 for the applicable fidelity level of the Vibration Cueing feature must be included in the list of functions and subjective tests. The following amends those requirements.			
		FEATURE FIDELITY LEVEL		
		G	**R**	**S**
	Translational lift effect (including transverse flow effect). Procedure: from a stabilised in-ground-effect (IGE) hover, begin a forward acceleration. When passing through the effective translational lift range, the noticeable effect will be a possible nose pitch-up in some rotorcraft, an increase in the rate of climb, and a temporary increase in vibration level (in some cases this vibration may be pronounced). This effect is experienced again upon deceleration through the appropriate speed range. During deceleration, the pitch and rate of climb will have the reverse effect, but there will be a similar, temporary increase in vibration level.	√	√	√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	Rotor out-of-track and/or out-of-balance condition including icing conditions. Procedure: select the malfunction or condition from the IOS. Start the engine(s) normally and check for an abnormal vibration for an out-of-track condition and check for an abnormal vibration for an out-of-balance condition. This test does not require becoming airborne. The abnormal vibration for out-of-track and out-of-balance conditions must be recognized in the frequency range of the inverse of the period P of rotation of the main rotor for each condition, i.e. 1/P for vertical vibration caused by an out-of-track condition, and 1/P for lateral vibration caused by an out-of-balance condition.	√	√	√
	Failure of dynamic vibration absorber or similar system as appropriate for the rotorcraft (e.g. droop stop or static stop). Procedure: the test may be accomplished any time the rotor is engaged. Select the appropriate failure at the IOS, note an appropriate increase in vibration and check that the vibration intensity and frequency increase with an increase in RPM and the vibration intensity increases with an increase in collective application.		√	√
	Tail rotor drive malfunction/vibrations. Procedure: with the engine(s) running and the rotor engaged, select the malfunction and note the immediate increase of medium frequency vibration. The tail rotor operates in the medium frequency range, normally estimated by multiplying the tail rotor gear box ratio by the main rotor RPM. The failure can be recognized by an increase in the vibrations in this frequency range. Vibrations may be transmitted via the pedals as well.	√	√	√
	High speed vibrations		√	√
	Buffet due to vortex ring state (settling with power). Note: Entering the vortex ring should result in both vibration/buffet cues (see CS FSTD.QB.109) and motion cueing. See details in section 15 below.		√	√
	Vibrations due to retreating blade stall. Note: Retreating blade stall should result in both vibration/buffet cues (see CS FSTD.QB.109) and motion cueing. See also section 14 above.		√	√
	Buffet due to atmospheric disturbances		√	√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
15	**MOTION AND MOTION EFFECTS** The requirements specified in CS FSTD.QB.110 for the applicable fidelity level of the Motion Cueing feature must be included in the list of functions and subjective tests. The following amends those requirements. The following motion cueing and effects are required to indicate the threshold at which a flight crew member must recognise an event or situation. Where applicable below, the FSTD pitch, side loading and directional control characteristics must be characteristics to the simulated aircraft.			
		FEATURE FIDELITY LEVEL		
		G	R	S
	Taxiing effects such as lateral, directional and longitudinal cues resulting from steering and braking inputs.			✓
	Effects of runway rumble, oleo deflections, ground speed, uneven runway, runway centre line lights, runway contamination and taxiway characteristics. Procedure: after the rotorcraft has been preset to the take-off position and then released, taxi at various speeds with a smooth runway and note the general characteristics of the simulated runway rumble effects. Repeat the manoeuvre with a runway roughness of 50% and with maximum roughness. Note the associated motion vibrations affected by ground speed and runway roughness. Similar tests are conducted on taxiways at various taxi speeds. The associated motion effects for the above tests must also include an assessment of the effects of rolling over centre line lights, of surface discontinuities of uneven runways, and of various taxiway characteristics. Different gross weights can also be selected as this may also affect the associated vibrations depending on the rotorcraft type			✓
	Friction drag from skid-type landing gear. Procedure: perform a running take-off or a running landing and note a change (increase or decrease) with speed in fuselage vibrations (as opposed to rotor vibrations) due to the friction of dragging the skid along the surface. This vibration will lessen as the ground speed decreases.	✓	✓	✓
	Bumps/buffets associated with landing gear. Procedure: perform a normal take-off paying special attention to the bumps that could be perceptible due to maximum oleo extension after lift-off. When the landing gear is extended or retracted, motion bumps may be felt when the gear locks into position.			✓

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	Cues resulting from touchdown. Procedure: conduct several touchdowns with various rates of descent, from a hover and run-on. Check that the motion cues for the touchdown bumps for each descent rate and speed reflect the actual rotorcraft.		√	√
	Tire failures. Procedure: simulate tire failures and note effects of yaw, motion, vibration and sound effects. The pilot may notice some yawing with a failure of multiple tires selected on the same side. This must require the use of the pedal to maintain control of the rotorcraft. Dependent on the rotorcraft type, a single tire failure may not be noticed by the pilot and may not cause any special motion effect. Sound or vibration may be associated with the actual tire losing pressure.		√	√
	Engine malfunction and engine damage effects. Procedure: the characteristics of an engine malfunction as prescribed in the malfunction definition document for the particular FSTD must describe the special motion effects felt by the pilot. Note the associated engine instruments varying according to the nature of the malfunction and note the replication of the effects of the airframe vibrations.	√	√	√
	Tail strikes. Procedure: tail-strikes can be checked by over-rotation of the rotorcraft at a quick stop or during autorotation to the ground. It can also be checked in the hover by a rapid aft cyclic input. The motion effect must be felt initially by a motion bump as the tail guard hits the surface. A nose down pitching moment may possibly be noticeable after the strike.		√	√

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	Buffet due to vortex ring state (settling with power). Note: Entering the vortex ring should result in both vibration/buffet cues (see CS FSTD.QB.109) and motion cueing. See also section 14 above. Procedure: procedures may differ between rotorcraft and may be prescribed by the rotorcraft manufacturer. However, the following information is provided for illustrative purposes. To enter the manoeuvre, reduce power below hover power descending vertically or near vertically, allowing sink rate to increase to 1.5 m/s (300 ft/min) or more (actual sink rate value will depend on the rotorcraft type simulated). Adjust attitude to obtain airspeeds of less than 10 knots. The aircraft will shudder entering the vortex ring state. During the initial stage (when a large amount of excess power is available), a large application of collective pitch may arrest rapid descent. If done carelessly or too late, collective increase can aggravate the situation resulting in more turbulence and an increased rate of descent and an increase in vibrations level. In single-rotor rotorcraft, the recovery can be accomplished by applying cyclic to gain airspeed and arrest the upward induced flow of air and/or by lowering the collective (altitude permitting). Normally, gaining airspeed is the preferred method as less altitude is lost. In tandem-rotor rotorcraft, fore and aft cyclic inputs aggravate the situation. By lowering thrust (altitude permitting) and applying lateral cyclic input or pedal input to arrest the upward induced flow of air, the pilot can accomplish recovery.		✓	✓

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)			
	Retreating blade stall. Note: Retreating blade stall should result in both vibration/buffet cues (see CS FSTD.QB.109) and motion cueing. See also section 14 above. Procedure: procedures may differ between rotorcraft and may be prescribed by the rotorcraft manufacturer or other subject matter expert. However, the following information is provided for illustrative purposes: to enter the manoeuvre, increase forward airspeed; the effect will be recognized through the development of a low frequency vibration, pitching up of the nose, and a roll in the direction of the retreating blade. High weight, low rotor RPM, high density altitude, turbulence or steep, abrupt turns are all conducive to retreating blade stall at high forward airspeeds. Correct recovery from retreating blade stall requires the collective to be lowered first, which reduces the disk loading. Aft cyclic can then be used to slow the rotorcraft.		✓	✓
16	**SOUND SYSTEM** The requirements specified in CS FSTD.QB.108 for the applicable fidelity level of the Sound Cueing feature must be included in the list of functions and subjective tests. The following amends those requirements. Note: Checks must be performed with the motion and vibration systems ON.			
		FEATURE FIDELITY LEVEL		
		G	**R**	**S**
	Precipitation		✓	✓
	Rain removal equipment (e.g. wipers)		✓	✓
	Significant rotorcraft noises perceptible to the pilot during normal operations, such as noises from engine, transmissions, rotors or other sources, to a level comparable to that found in the rotorcraft .	✓	✓	✓
	Significant rotorcraft flight deck sounds and those which result from an action by the pilot.	✓	✓	✓
	Abnormal operations for which there are associated sound cues including, but not limited to, engine, rotors, transmissions malfunctions, landing gear/tire malfunctions and tail guard/stinger/hockey stick strike.	✓	✓	✓
	Sound of a crash when the rotorcraft is landed in excess of limitations or in unusual attitudes.	✓	✓	✓
17	**SPECIAL EFFECTS**			
	Effects of airframe, engine and rotor icing. Procedure: with the FSTD airborne, in a clean configuration, nominal altitude and cruise airspeed, autopilot ON, engine and airfoil anti-ice/de-ice systems deactivated,			

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)
	activate icing conditions at a rate that allows monitoring of FSTD and systems response. Icing recognition will include an increase in gross weight, increase in power required to maintain level flight, airspeed decay, change in FSTD pitch attitude, change in engine performance indications (other than due to airspeed changes), and change in data from pitot/static system, or symptoms of rotor out-of-track or out-of-balance. Activate heating, anti-ice, or de-ice systems independently. Recognition will include proper effects of these systems, eventually returning the simulated aircraft to normal flight.
	Airflow patterns and respective effects associated with large structures, such as buildings and oil rigs, confined areas, mountain peaks including demarcation lines, etc.
	Special atmospheric effects, as may be required for a particular training programme, such as arctic sea smoke, katabatic winds, mountain effects (rotors, demarcation lines, etc.), oil rig exhaust turbulence, wake vortices and downwash effects from other aircraft, etc.
18	**INSTRUCTOR OPERATING STATION (IOS)** The requirements specified in CS FSTD.QB.115 must be included in the list of functions and subjective tests. The following amends those requirements. Note: The list below is not exhaustive but is intended to list the sorts of functionalities that must be available to support the intended use, depending on the FSTD and FCS.
	● Repositions: Note: Repositions must be in-trim at the appropriate speed and configuration for the point. ○ Parking spot ○ Take-off position ○ Approach position (at least three positions at 1.8, 5.5 and 9.3 km (1, 3 and 5 NM) from the runway threshold. ○ Elevated surface position (building top, offshore oil rig, etc.) ○ Confined landing area ○ On a slope ● Resets: ○ System ○ Temperature ○ Fluids and agents ● Weather presets: ○ Unlimited, CAVOK, VFR, non-precision, APV, precision (CAT I, CAT II, CAT III), EFVS (if appropriate) ● Visual effects: ○ Time of day (day, dusk or dawn, night) ○ Clouds (bases, tops, layers, types, density) ○ Visibility in kilometres/statute miles ○ RVR in metres/feet ○ Special effects (precipitation; thunderstorms; blowing snow; blowing sand; etc.) ○ Sand/dust/snow/water downwash/recirculation effect ON/OFF ○ Sea state conditions (0-6) ● Wind speed and direction:

NUMBER	FUNCTIONS AND SUBJECTIVE TESTS (ROTORCRAFT)
	○ Surface ○ Intermediate levels ○ Typical gradient ○ Gusts with associated heading and speed variance ○ Turbulence ● Temperature — surface ● Atmospheric pressure (QNH, QFE) ● Airport/heliport visual effects: ○ To include active runway or landing area selection ○ Airport/heliport lighting controls ○ Airport/heliport preset positions (take-off, approach, oil rig, etc.) ○ Landing surface conditions (rough, smooth, icy, wet, etc.) ○ Dynamic effects including ground and airborne traffic ● Aircraft configuration (fuel, weight, CG, etc., in imperial and metric units): ○ Gross weight ○ Fuel loading ○ Payload ○ CG (in units appropriate to the aircraft type, e.g. inches, mm) ○ Aircraft Systems status/control (e.g. rapid navigation system (NAV) alignment (IRS, GPS, AHRS), others) ○ Ground crew functions (ground power, etc.) ● Storing and recalling the FMS data unless precluded by installed equipment ● Ground crew functions (e.g. external power, air, pushback) ● Plotting and recording (take-off and approach) ● Aircraft malfunctions (inserting and removing, trigger based on speed, altitude, etc.) ● Sound controls (ON, OFF and adjustment; indication of when the sound level is set to a value other than the approved level) ● Motion system (ON, OFF and emergency stop) ● Control loading system (ON, OFF and emergency stop) ● Vibration system (ON, OFF and emergency stop) ● FSTD master/emergency power switch 'OFF' ● Observer seats position/adjustment system and positive restraint system for FSTD with motion (e.g. safety belt, shoulder harness) ● Communication between the instructor/observer(s) and the flight crew ● Freezes/resets: ○ Complete simulation freeze ○ Flight/problem freeze ○ Position freeze ○ Fuel freeze ○ Ground speed control ○ Standard atmosphere reset ○ Aircraft system resets (e.g. resetting engine fire bottles after their use)

MISCELLANEOUS

GM1 CS FSTD.FST.105 Table of Functions and Subjective Tests

This GM gives guidance on the use of the functions and subjective test table.

(a) General

Table 1 below shows a partially completed example of the information that could be recorded during functions and subjective testing. Table 1 is just one example of how this could be achieved. It is up to the organisation requesting qualification of an FSTD to determine the level of detail appropriate to the requested FCS for review with the competent authority during the initial evaluation.

(b) Remark

The 'Remark' column should have any appropriate detail on the appropriate item, such as:

(1) ATA chapter malfunctions assessed,

(2) visual scenes assessed,

(3) specific PBN approaches conducted,

(4) low-visibility taxi routes assessed,

(5) low-visibility ops minima, etc.

This will also assist the operator in completing the relevant sections of the ESL.

(c) Result

(d) The 'Result' column shall indicate whether a test has been assessed satisfactorily or otherwise. Where a result has been declared unsatisfactory, it may be useful to annotate a reference to any relevant declared discrepancy for transparency.

(e) Used abbreviations in the example below are 'SAT' for a satisfactory result and 'UNSAT' for unsatisfactory result with 'DR' standing for a discrepancy report.

Table 1. Example of partially completed functions and subjective test list

NUMBER	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	REMARK	RESULT
1	**FLIGHT DECK LAYOUT AND STRUCTURE AND AIRCRAFT SYSTEMS OPERATION**		
	• The hardware and system functions must be checked to comply with the general requirements for the FCS: The systems must be checked to comply with the information in the ESL in all flight phases.		**SAT ~~/ UNSAT~~**
2	**PREPARATION FOR FLIGHT**		

	• Accomplish a functions check of all switches, indicators, systems, and equipment at all crew members' and instructors' stations.	The flight deck design and functions are identical to those of B737-800W	**SAT ~~/ UNSAT~~**
3	**SURFACE OPERATIONS (PRE-FLIGHT)**		
3.a	**Engine start**		
	• Normal start		**SAT / ~~UNSAT~~**
	• Alternate start procedures	Manual start Ext air, APU, X-bleed	**SAT ~~/ UNSAT~~**
	• Abnormal starts and shutdowns (hot start, hung start)		**SAT ~~/ UNSAT~~**
3.b	**Taxi**		
	• Pushback	EDDF A25 (Left, right and straight)	**SAT ~~/ UNSAT~~**
	• Thrust response		**SAT ~~/ UNSAT~~**
	• Power lever friction		**~~SAT~~ / UNSAT DR106**
	• Ground handling		**SAT ~~/ UNSAT~~**
……	……	…..	…..
7	**DESCENT**		
	• Normal rate		**SAT ~~/ UNSAT~~**
	• Maximum rate/emergency (clean and with speedbrake.)		**SAT ~~/ UNSAT~~**
	• With autopilot		**SAT ~~/ UNSAT~~**
8	**INSTRUMENT APPROACHES OPERATIONS**		
8.a	3D operations on precision approach procedures:		
	• CAT I published approaches:		
	○ Manual approach with/without flight director including landing	EDDF 25C	**SAT ~~/ UNSAT~~**
	○ Autopilot/autothrottle coupled approach and manual landing	EDDF 25L	**SAT ~~/ UNSAT~~**
……	……	…..	…..

CS FSTD.FST.040 Table of Functions and Subjective Tests for Simulated Air Traffic Control Environment (SATCE)

SATCE is not a mandatory requirement. If the FSTD shall be used with a SATCE system, the following table shall be used for the functions and subjective tests for aeroplane and rotorcraft FSTDs. The QTG must include a list of functions and subjective tests that meet the applicable requirements specified in CS FSTD.QB.SATCE, corresponding to the fidelity level of the FSTD. Table 1 below amends those requirements.

Table 1.

19	**SIMULATED AIR TRAFFIC CONTROL ENVIRONMENT (SATCE)** SATCE tests are applicable only if the FSTD must be used with a SATCE system (see CS FSTD.QB.SATCE). The requirements specified in CS FSTD.QB.SATCE must be included in the list of functions and subjective tests. The following amends those requirements. Note: Features that are unrealistic or could potentially disrupt training (for example, issues with the visual representation of other traffic, ATC communication errors and incorrect clearances) must be corrected or removed.
19.a	Automated weather reporting:

	• Instructor control
	• Correlation with reported weather
	• Station weather reporting:
	    o Single message
	    o Message contents
	    o Multiple messages
	• Message format and regional characteristics:
	    o Regional / ICAO

19.b	Other Traffic:

	• Other aeroplanes
	• Other traffic automation
	• Other aircraft performance
	• Other aeroplane behaviour:
	    o Appropriate routing
	    o Category and weight class
	• Other traffic transponder state
	• Other traffic transponder mode of operation
	• Other traffic correlation with ATC
	• Other traffic separation
	• Other aeroplane call sign and livery
	• Other aeroplane type and livery
	• Other aeroplane visual effects

19.c	Background radio communications:
	• Presence • Atc services and other traffic operations

	• Errors
	• Number of transmissions
	• Overstepping on frequency:
	  o Other traffic and ATC
	  o Ownship

19.d	ATC services:

	• ATC service provision
	• Roles and frequency allocation
	• ATC procedures:
	  o Standard
	  o Regional
	  o Correlation
	• Radio ranging
	• ATC service continuity

19.e	Language and phraseology:

	• Language:
	  o English
	• Standard phraseology:
	  o ICAO
	  o Regional

19.f	Voice characteristics:

	• ATC voice assignment
	• Dedicated ATC voices
	• ATC voices:
	  o Distinct
	  o Multiple distinct
	• Other traffic voices:
	  o Distinct
	  o Multiple distinct

19.g	Airport and airspace modelling:

	• Airports:
	  o Single airport
	  o Multiple airports
	• Controlled airspace:
	  o Terminal and enroute
	  o Location-specific terminal and en-route
	• Minimum connected ground movement areas
	• Multiple connected ground movement areas
	• Single direction runway movements
	• Multiple runways
	• Runway operation modes
	• Airport runway lighting
	• Holding point lighting
	• Taxiway lighting

19.h	Weather:
	• Airport operations and reported weather • Atc procedures and reported weather

19.i	Voice communications:

	• Voice continuity
	• Time of day
	• Communication initiation
	• Atc services and ownship operations
	• Ownship emergency conditions
	• ATC service continuity
	• Standby
	• Say again
	• Content errors and omissions
	• Incorrect frequency transmissions
	• Clearance deviations.
	• Ownship routing:
	    o According to flight plan
	    o Published routes
	    o Appropriate runways
	    o Appropriate ground routing

19.j	Data link communications:

	• Message sequence
	• Message indications
	• Timing delays
	• ATS clearances
	• Data link weather
	• DLIC
	• Connection management
	• CPDLC:
	    o Messaging capability
	    o Regional messaging
	• ADS-C
	• FIS-B
	• Service failures

19.k	System correlation:

	• Traffic on visual system
	    o Presence
	    o Alignment
	• Visual system clutter
	• Navigation data alignment
	    o Other aeroplanes
	    o Airspace
	• Traffic on flight deck displays
	• ADS-B traffic
	• TCAS
	    o Ownship event triggering
	    o Ownship standard procedures and radio communications

19.l	Instructor interfaces and controls:
	• Situational awareness • Instructor access to radio communications • Instructor access to data link communications

	• Simulator functions
	  ○ Minimum support
	• Disable SATCE
	• Mute (background radio communications)
	• Instructor other traffic control
	  ○ Presence
	  ○ Configurable flow