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SUBPART A – APPLICABILITY

YCAR–STD 1A.001 Applicability

YCAR–STD 1A as amended applies to those persons, organisations or enterprises (flight simulator operators) seeking initial qualification of flight simulators.

The version of YCAR-STD 1A agreed by the Authority and used for issue of the initial qualification shall be applicable for future recurrent qualifications of the flight simulator unless re-categorised.

Flight simulator users also shall gain approval to use the flight simulator as part of their approved training programmes despite the fact that the flight simulator has been previously qualified. Although this document provides guidance material for flight simulator users, precise details of such approvals are contained in YCAR–OPS and other applicable documents.

Note: In the context of this YCAR-STD, the "Authority" means CAMA except that whenever a foreign authority is utilized for the qualification of simulators, the term "Authority" may also apply to this foreign Authority.

SUBPART B – GENERAL

YCAR–STD 1A.005 Terminology
(See AC STD 1A.005)

Because of the technical complexity of STD qualification, it is essential that standard terminology is used throughout. The following principal terms and abbreviations shall be used in order to comply with YCAR–STD (A). Further terms and abbreviations are contained in AC STD 1A.005.

(a) *Synthetic Training Device (STD).* A training device which is either a Flight Simulator (FS), a Flight Training Device (FTD), a Flight & Navigation Procedures Trainer (FNPT) , or a Basic Instrument Training Device (BITD).

(b) *Flight Simulator (FS).* A full size replica of a specific type or make, model and series aeroplane flight deck, including the assemblage of all equipment and computer programmes necessary to represent the aeroplane in ground and flight operations, a visual system providing an out of the flight deck view, and a force cueing motion system. It is in compliance with the minimum standards for Flight Simulator Qualification.

(c) *Flight Training Device (FTD).* A full size replica of an aeroplane's instruments, equipment, panels and controls in an open flight deck area or an enclosed aeroplane flight deck, including the assemblage of equipment and computer software programmes necessary to represent the aeroplane in ground and flight conditions to the extent of the systems installed in the device. It does not require a force cueing motion or visual system. It is in compliance with the minimum standards for a specific FTD Level of Qualification.

(d) *Flight and Navigation Procedures Trainer - (FNPT).* A training device which represents the flight deck/cockpit environment including the assemblage of equipment and computer programmes necessary to represent an aeroplane in flight operations to the extent that the systems appear to function as in an aeroplane. It is in compliance with the minimum standards for a specific FNPT Type of Qualification.

(e) *Basic Instrument Training Device (BITD).* A ground based training device which represents the student pilot's station of a class of aeroplanes. It may use screen based instrument panels and spring-loaded flight controls, providing a training platform for at least the procedural aspects of instrument flight.

(f) Synthetic Training Device Approval (STD Approval). The extent to which an STD of a specified Qualification Level may be used by persons, organisations or enterprises as approved by the Authority. It takes account of aeroplane to STD differences and the operating and training ability of the organisation.

(g) *Synthetic Training Device Operator (STD operator).* That person, organisation or enterprise directly responsible to the Authority for requesting and maintaining the qualification of a particular STD.

(h) *Synthetic Training Device User (STD User).* The person, organisation or enterprise requesting training, checking and testing credits through the use of an STD.

(i) *Synthetic Training Device Qualification (STD Qualification).* The level of technical ability of an STD as defined in the compliance document.

(j) *Qualification Test Guide (QTG).* A document designed to demonstrate that the performance and handling qualities of an STD agree within prescribed limits with those of the aeroplane and that all applicable regulatory requirements have been met. The QTG includes both the aeroplane and STD data used to support the validation.

SUBPART C – AEROPLANE FLIGHT SIMULATORS

YCAR–STD 1A.015 Application for Flight Simulator Qualification

(See AC No. 1 to YCAR-STD 1A.015)

(See AC No. 2 to YCAR- STD 1A.015)

(a) The STD operator requiring evaluation shall apply to the Authority giving 3 months notice. In exceptional cases this period may be reduced to one month at the discretion of the Authority.

(b) An STD (FS) Qualification Certificate will be issued following satisfactory completion of an evaluation by the Authority.

YCAR–STD 1A.020 Validity of Flight Simulator Qualification

(See AC STD 1A.020(a))

(a) An STD qualification is valid for 12 months unless otherwise specified by the Authority.

(b) An STD qualification revalidation may take place at any time within the 60 days prior the expiry of the validity of the qualification document. The new period of validity shall continue from the expiry date of the previous qualification document.

(c) The Authority may refuse, revoke, suspend or vary an STD qualification, if the provisions of YCAR–STD 1A are not satisfied.

YCAR–STD 1A.025 Rules governing Flight Simulator Operators

(See AC YCAR-STD 1A.025)

The STD operator shall demonstrate his capability to maintain the performance, functions and other characteristics specified for the STD Qualification Level as follows:

(a) *Quality System*

(1) A Quality System shall be established and a Quality Manager designated to monitor compliance with, and the adequacy of, procedures required to ensure the maintenance of the Qualification Level of STDs. Compliance monitoring shall include a feedback system to the Accountable Manager to ensure corrective action as necessary.

(2) The Quality System shall include a Quality Assurance Programme that contains procedures designed to verify that the specified performance, functions and characteristics are being conducted in accordance with all applicable requirements, standards and procedures.

(3) The Quality System and the Quality Manager shall be acceptable to the Authority.

(4) The Quality System shall be described in relevant documentation.

(b) *Updating*. Maintain a link with manufacturers to incorporate important modifications, especially:

(1) Aeroplane modifications. Aeroplane modifications, whether or not enforced by an airworthiness directive, and which are essential for training and checking, shall be introduced into all affected STDs.

(2) Modification of STDs, including motion and visual systems:

(i) Where applicable and essential for training and checking, STD operators shall update their STDs (for example in the light of data revisions). Modifications of the STD hardware and software which affect flight, ground handling and performance or any major modifications of the motion or visual system shall be evaluated to determine the impact on the original qualification criteria. If necessary, STD operators shall prepare amendments for any affected validation tests. The STD operator shall test the STD to the new criteria.

(ii) The Authority shall be advised in advance of any major changes to determine if the tests carried out by the STD operator are satisfactory. A special evaluation of the STD may be necessary prior to returning it to training following the modification.

(c) *Installations.* Ensure that the flight simulator is housed in suitable premises which support safe and reliable operation.

(1) The STD operator shall ensure that the flight simulator and its installation comply with the local, country or state regulations for health and safety. However as a minimum the following shall be addressed:

(i) Flight simulator occupants and maintenance personnel shall be briefed on flight simulator safety to ensure that they are aware of all safety equipment and arrangement in the flight simulator in case of emergency.

(ii) Adequate fire/smoke detection, warning and suppression arrangements to ensure the safe passage of personnel from the flight simulator.

(iii) Adequate protection against electrical, mechanical, hydraulic and pneumatic hazards – including those arising from the control loading & motion systems to ensure the maximum safety of all personnel in the vicinity of the flight simulator.

(iv) Other items:

(A) Two way communication system which remains operational in the event of total power failure.

(B) Emergency lighting.

(C) Escape exits & facilities.

(D) Occupant restraints (seats, seat belts etc.).

(E) External warning of motion and access ramp or stairs activity.

(F) Danger area markings.

(G) Guard rails and gates.

(H) Motion & control loading emergency stop controls accessible from either pilot and instructor seats; and

(I) A manual or automatic electrical power isolation switch.

(2) The flight simulator safety features such as emergency stops and emergency lighting shall be checked regularly by the STD operator but in any case at least annually. These tests shall be recorded.

YCAR–STD 1A.030 Requirements for Flight Simulators qualified on or after 1 April 1998

(See Appendix 2 to YCAR–STD 1A.030)

(See AC No. 1 to YCAR- STD 1A.030)

(See AC No. 2 to YCAR- STD 1A.030)

(a) Any flight simulator submitted for initial evaluation on or after 1 April 1998, will be evaluated against applicable YCAR–STD 1A criteria for Qualification Levels A, B, C or D. Recurrent evaluations of a flight simulator will be based on the same version of YCAR-STD 1A, which was applicable for its initial evaluation. An upgrade will be based on the currently applicable version of YCAR-STD 1A.

(b) A flight simulator shall be assessed in those areas which are essential to completing the flight crew member training and checking process, including:

(1) Longitudinal, lateral and directional handling qualities.

(2) Performance on the surface and in the air.

(3) Specific operations where applicable.

(4) Flight deck configuration.

(5) Functioning during normal, abnormal, emergency and, where applicable, non-normal operation.

(6) Instructor station function and simulator control; and

(7) Certain additional requirements depending on the Qualification Level and the installed equipment.

(c) The flight simulator shall be subjected to:

(1) Validation tests (See AC No. 1 to YCAR-STD 1A.030, para 2.3, AC No. 1 to YCAR-STD 1A.030(c)(1) and AC No. 2 to YCAR-STD 1A.030(c)(1)); and

(2) Functions & subjective tests (See AC No. 1 to YCAR-STD 1A.0300, para 3).

(d) Data which are used to ensure the fidelity of a flight simulator shall be of a standard that satisfies the Authority before the flight simulator can gain a Qualification Level.

(e) The STD operator shall submit a QTG in a form and manner acceptable to the Authority.

(f) Upon completion of an initial or upgrade evaluation, and when all the discrepancies in the QTG have been addressed to the satisfaction of the Authority, the QTG is approved. After inclusion of the results of the tests witnessed by the Authority, the approved QTG becomes the Master QTG (MQTG), which is the basis for the flight simulator qualification and subsequent recurrent flight simulator evaluations.

(g) The STD operator shall:

(1) Run the complete MQTG progressively between each annual evaluation by the Authority. Results shall be dated and retained in order to satisfy both the STD operator as well as the Authority that flight simulator standards are being maintained; and

(2) Establish a Configuration Control System to ensure the continued integrity of the hardware and software qualified.

YCAR–STD 1A.035 Requirements for Flight Simulators approved or qualified before 1 April 1998

(See AC YCAR-STD 1A.035)

(a) Flight simulators approved or qualified in accordance with national regulations before 1 April 1998 either will be re-categorised or will continue to maintain their approval under the Grandfather Rights provision, in accordance with sub-paragraphs (c) and (d) below.

(b) Re-categorised flight simulators will be qualified in accordance with YCAR–STD 1A.030.

(c) Flight simulators that are not re-categorised but that have a primary reference document used for their testing may be qualified by the Authority to an equivalent YCAR–STD 1A Qualification Level, either AG, BG, CG or DG. These Qualification Levels refer to similar credits achieved by YCAR–STD 1A Levels A, B, C & D. An upgrade requires the re-categorisation of the flight simulator.

(1) To gain and maintain an equivalent Qualification Level, these flight simulators shall be assessed in those areas which are essential to completing the flight crew member training and checking process, including:

(i) Longitudinal, lateral and directional handling qualities.

(ii) Performance on the ground and in the air.

(iii) Specific operations where applicable.

(iv) Flight deck configuration.

(v) Functioning during normal, abnormal, emergency and, where applicable non-normal operation.

(vi) Instructor station function and simulator control; and

(vii) Additional requirements depending on the Qualification Level and the installed equipment.

(2) The flight simulators shall be subjected to:

(i) Validation tests; and

(ii) Functions and subjective Tests.

(d) Flight simulators that are not re-categorised and that do not have a primary reference document used for their testing shall be qualified by special arrangement. Such flight simulators will be issued with Special Categories and shall be subjected to the same functions and subjective tests referred to in sub-paragraph (c)(2)(ii) above. In addition any previously recognised validation test shall be used.

YCAR–STD 1A.040 Changes to qualified Flight Simulators

(a) *Requirement to notify major changes to a Flight Simulator.* The operator of a qualified STD shall inform the Authority of proposed major changes such as:

(1) Aeroplane modifications which could affect flight simulator qualification.

(2) Flight simulator hardware and/or software modifications which could affect the handling qualities, performances or system representations.

(3) Relocation of the flight simulator; and

(4) Any deactivation of the flight simulator.

The Authority may complete a special evaluation following major changes or when a flight simulator appears not to be performing at its initial Qualification Level.

(b) *Upgrade of a Flight Simulator.* A flight simulator may be upgraded to a higher Qualification Level. Special evaluation is required before the award of a higher Level of Qualification.

(1) If an upgrade is proposed the STD operator shall seek the advice of the Authority and give full details of the modifications. If the upgrade evaluation does not fall upon the anniversary of the original qualification date, a special evaluation is required to permit the flight simulator to continue to qualify even at the previous Qualification Level.

(2) In the case of a flight simulators flight simulators upgrade, an STD operator shall run all validation tests for the requested Qualification Level. Validation test results offered in a test guide for previous initial or upgrade evaluation shall not be used to validate simulator performance in a test guide offered for a current upgrade.

(c) *Relocation of a Flight Simulator*

(1) In instances where a flight simulator is moved to a new location, the Authority shall be advised before the planned activity along with a schedule of events related thereto.

(2) Prior to returning the simulator to service at the new location the STD operator shall perform at least one third of the validation tests (if any) and, functions and subjective tests to ensure that the flight simulator performance meets its original qualification standard. A copy of the test documentation shall be retained with the flight simulator records for review by the Authority.

(3) At the discretion of the Authority, the flight simulator shall be subject to an evaluation in accordance with its original qualification criteria.

(d) *Deactivation of a currently qualified Flight Simulator*

(1) In the event a STD operator plans to remove a flight simulator from active status for prolonged periods, the Authority shall be notified and suitable controls established for the period the flight simulator is inactive.

(2) The STD operator shall agree a procedure with the Authority to ensure that the flight simulator can be restored to active status at its original Qualification Level.

YCAR–STD 1A.045 Interim Flight Simulator Qualification

(See AC STD 1A.045)

(a) In case of new aeroplane programmes, special arrangements shall be made to enable an interim Qualification Level to be achieved.

(b) Requirements, details relating to the issue, and the period of validity of an interim Qualification Level will be decided by the Authority.

YCAR–STD 1A.050 Transferability of Flight Simulator Qualification

(a) When there is a change of STD operator, the new operator shall advise the Authority in advance in order to agree upon a plan of transfer of the flight simulator.

(b) At the discretion of the Authority, the flight simulator shall be subject to an evaluation in accordance with its original qualification criteria.

(c) Provided that the flight simulator performs to its original standard, its original Qualification Level shall be restored.

Appendix 1 to YCAR–STD 1A.030

Minimum technical Requirements for Flight Simulator Qualification Levels

(a) This Appendix describes the minimum technical requirements for qualifying Level A, B, C and D flight simulators.

(1) Each of those four levels carries an appropriate technical description and maximum training, checking and testing credits.

(2) The training, checking and testing credits do not imply an automatic level of approval for any flight simulator user.

(3) Table 1 indicates in broad terms the maximum credits possible for each technical Qualification Level. Specific requirements for the use of the aeroplane or flight simulator will be determined by the Authority. Specialised training courses (e.g. ETOPS, TCAS, AWOPS, windshear etc.) require an adequate standard of simulation which will be evaluated by the Authority.

(b) Certain flight simulator and visual system requirements included in this Appendix shall be supported with a statement of compliance (SOC) and, in some designated cases, an objective test. Compliance statements shall describe how the requirement was met, such as gear modelling approach, coefficient of friction sources, etc.

Table 1 – Minimum technical requirements for qualifying Level A, B, C and D Flight Simulators

Qualification Level	**General Technical Requirements**	**Maximum Credits**
A	The lowest level of flight simulator technical complexity. An enclosed full scale replica of the aeroplane cockpit/flight deck including simulation of all systems, instruments, navigational equipment, communications and caution and warning systems. An instructor's station with seat shall be provided as shall be seats for the flight crewmembers and one seat for inspectors/observers. Control forces and displacement characteristics shall correspond to that of the replicated aeroplane and they shall respond in the same manner as the aeroplane under the same flight conditions. The use of class specific data tailored to the specific aeroplane type with fidelity sufficient to meet the objective tests, functions and subjective tests is allowed. Generic ground effect and ground handling models are permitted. Motion, visual and sound systems sufficient to support the training, testing and checking credits sought are required. The visual system shall provide at least 45 degrees horizontal and 30 degrees vertical field of view per pilot. A night scene is acceptable. The response to control inputs shall not be greater than 300 milliseconds more than that experienced on the aircraft. Wind shear need not be simulated.	Suitable for: – Crew procedures training. – Instrument flight training. – Transition/conversion training, testing and checking except for take off and landing manoeuvres. – Recurrent training, checking and testing (type and instrument rating renewal/revalidation)
B	As for Level A plus: Validation flight test data shall be used as the basis for flight and performance and systems characteristics. Additionally ground handling and aerodynamics programming to include ground effect reaction and handling characteristics shall be derived from validation flight test data.	As for Level A plus: – Recency of experience (three take-offs and landings in 90 days). – Transition/conversion training for take-off and landing manoeuvres. – Transition/conversion testing and checking except for take-offs and landings.
C	The second highest level of flight simulator performance. As for Level B plus: A daylight/twilight/night visual system is required with a continuous, cross-cockpit, minimum collimated visual field of view providing each pilot with 180 degrees horizontal and 40 degrees vertical field of view. A six axes motion system shall be provided. The sound simulation shall include the sounds of precipitation and other significant aeroplane noises perceptible to the pilot and shall be able to reproduce the sounds of a crash landing. The response to control inputs shall not be greater than 150 milliseconds more than that experienced on the aeroplane. Wind shear simulation shall be provided.	As for Level B plus: – Transition/conversion testing and checking of take-offs and landings for flight crewmembers whose minimum experience level is defined by the Authority.

D	The highest level of flight simulator performance. As for Level C plus: There shall be complete fidelity of sounds and motion buffets.	As for Level C plus: – Transition/conversion testing and checking of take-off and landings for flight crews, who may be required to meet a minimum experience level defined by the Authority.

Appendix 2 to YCAR-STD 1A.030

Flight simulator standards

1 General. This appendix describes the minimum flight simulator requirements for qualifying flight simulators to the required Qualification Levels. Certain requirements included in this section shall be supported with a statement of compliance (SOC) and, in some designated cases, an objective test. The SOC will describe how the requirement was met, such as gear modelling approach, coefficient of friction sources etc. The test results shall show that the requirement has been attained. In the following tabular listing of flight simulator standards, statements of compliance are indicated in the compliance column.

FLIGHT SIMULATOR STANDARDS	SIMULATOR LEVEL				COMPLIANCE
	A	B	C	D	
a. Flight deck, a full scale replica of the aeroplane simulated. Direction of movement of controls and switches identical to that in the aeroplane. Equipment for operation of the cockpit windows shall be included in the flight simulator, but the actual windows need not be operable. The flight deck, for flight simulator purposes, consists of all that space forward of a cross section of the fuselage at the most extreme aft setting of the pilots' seats. Additional required flight crewmember duty stations and those required bulkheads aft of the pilot seats are also considered part of the flight deck and shall replicate the aeroplane.	✓	✓	✓	✓	Flight deck observer seats are not considered to be additional flight crewmember duty stations and may be omitted. Bulkheads containing items such as switches, circuit breakers, supplementary radio panels, etc. to which the flight crew may require access during any event after pre-flight cockpit preparation is complete are considered essential and may not be omitted. Bulkheads containing only items such as landing gear pin storage compartments, fire axes or extinguishers, spare light bulbs, aircraft document pouches etc. are not considered essential and may be omitted. Such items, or reasonable facsimile, shall still be available in the flight simulator but may be relocated to a suitable location as near as practical to the original position. Fire axes and any similar purpose instruments need only be represented in silhouette.
b. Circuit breakers that affect procedures and/or result in observable cockpit indications properly located and functionally accurate.	✓	✓	✓	✓	
c. Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight corresponding to actual flight conditions, including the effect of change in aeroplane attitude, thrust, drag, altitude, temperature, gross weight, moments of inertia, centre of gravity location, and configuration.	✓	✓	✓	✓	For level ‘A’ flight simulators generic ground handling, flare and touchdown effect are acceptable.

FLIGHT SIMULATOR STANDARDS	SIMULATOR LEVEL				COMPLIANCE
	A	B	C	D	
d. All relevant instrument indications involved in the simulation of the applicable aeroplane shall automatically respond to control movement by a flight crewmember or induced disturbance to the simulated aeroplane; e.g., turbulence or wind shear.	✓	✓	✓	✓	
e. Communications, navigation, and caution and warning equipment corresponding to that installed in the applicant's aeroplane with operation within the tolerances prescribed for the applicable airborne equipment.	✓	✓	✓	✓	
f. In addition to the flight crewmember duty stations, three suitable seats for the instructor/delegated examiner and Authority inspector. The Authority will consider options to this standard based on unique cockpit configurations. These seats shall provide adequate vision to the pilot's panel and forward windows. Observer seats need not represent those found in the aeroplane but shall be adequately secured to the floor of the flight simulator, fitted with positive restraint devices and be of sufficient integrity to safely restrain the occupant during any known or predicted motion system excursion.	✓	✓	✓	✓	
g. Flight simulator systems shall simulate applicable aeroplane system operation, both on the ground and in flight. Systems shall be operative to the extent that all normal, abnormal, and emergency operating procedures can be accomplished.	✓	✓	✓	✓	
h. Instructor controls shall enable the operator to control all required system variables and insert abnormal or emergency conditions in the aeroplane systems.	✓	✓	✓	✓	
i. Control forces and control travel shall correspond to that of the replicated aeroplane. Control forces shall react in the same manner as in the aeroplane under the same flight conditions.	✓	✓	✓	✓	

FLIGHT SIMULATOR STANDARDS	SIMULATOR LEVEL A	B	C	D	COMPLIANCE
j. Ground handling and aerodynamic programming shall include: (1) Ground Effect. For example: round-out, flare, and touchdown. This requires data on lift, drag, pitching moment, trim, and power ground effect. (2) Ground reaction – reaction of the aeroplane upon contact with the runway during landing to include strut deflections, tyre friction, side forces, and other appropriate data, such as weight and speed, necessary to identify the flight condition and configuration. (3) Ground handling characteristics – steering inputs to include crosswind, braking, thrust reversing, deceleration and turning radius.	✓	✓	✓	✓	Statement of Compliance required. Tests required. For Level 'A' flight simulators, generic ground handling may be represented to the extent that allows turns within the confines of the runway and adequate control on the landing and roll-out from a cross - wind landing.
k. Windshear models shall provide training in the specific skills required for recognition of wind shear phenomena and execution of recovery manoeuvres. Such models shall be representative of measured or accident derived winds, but may include simplifications which ensure repeatable encounters. For example, models may consist of independent variable winds in multiple simultaneous components. Wind models shall be available for the following critical phases of flight: (1) Prior to take-off rotation (2) At lift-off (3) During initial climb (4) Short final approach			✓	✓	Tests required. See AC No 1 to YCAR-STD 1A.030, para 2.3, g.
l. Instructor controls for environmental effects including wind speed and direction shall be provided.	✓	✓	✓	✓	

FLIGHT SIMULATOR STANDARDS	SIMULATOR LEVEL A	B	C	D	COMPLIANCE
m. Stopping and directional control forces shall be representative for at least the following runway conditions based on aeroplane related data: (1) Dry (2) Wet (3) Icy (4) Patchy wet (5) Patchy icy (6) Wet on rubber residue in touchdown zone.			✓	✓	Statement of Compliance required. Objective Tests required for (1), (2), (3), Subjective check for (4), (5), (6).
n. Brake and tyre failure dynamics (including antiskid) and decreased brake efficiency due to brake temperatures shall be representative and based on aeroplane related data.			✓	✓	Statement of Compliance required. Subjective test is required for decreased braking efficiency due to brake temperature, if applicable.
o. A means for quickly and effectively conducting daily testing of flight simulator programming and hardware shall be available.			✓	✓	Statement of Compliance required.
p. Flight simulator computer capacity, accuracy, resolution, and dynamic response shall be sufficient to fully support the overall flight simulator fidelity.	✓	✓	✓	✓	Statement of Compliance required.

FLIGHT SIMULATOR STANDARDS	SIMULATOR LEVEL A	B	C	D	COMPLIANCE
q. Control feel dynamics shall replicate the aeroplane simulated. Free response of the controls shall match that of the aeroplane within the tolerances specified. Initial and upgrade evaluations will include control free response (pitch, roll and yaw controller) measurements recorded at the controls. The measured responses shall correspond to those of the aeroplane in take-off, cruise, and landing configurations. 1) For aeroplanes with irreversible control systems, measurements may be obtained on the ground if proper pitot static inputs are provided to represent conditions typical of those encountered in flight. Engineering validation or aeroplane manufacturer rationale will be submitted as justification to ground test or omit a configuration. (2) For flight simulators requiring static and dynamic tests at the controls, special test fixtures will not be required during initial evaluation if the STD operator's MQTG shows both text fixture results and alternate test method results such as computer data plots, which were obtained concurrently. Repetition of the alternate method during initial evaluation may then satisfy this requirement.			✓	✓	Tests required.

FLIGHT SIMULATOR STANDARDS	SIMULATOR LEVEL A	B	C	D	COMPLIANCE
r. Relative response of the visual system, cockpit instruments and initial motion system response shall be coupled closely to provide integrated sensory cues. 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 system dynamic response limit of 150 milliseconds. Motion onset shall also occur within the system dynamic response limit of 150 milliseconds. Motion onset shall occur before the start of the scan of the first video field containing different information but shall occur before the end of the scan of the same video field. 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 pilot's seats, the output signal to the visual system display (including visual system analogy delays), and the output signal to the pilot's attitude indicator or an equivalent test approved by the Authority. The following two methods are acceptable means to prove compliance with the above requirement:	✓	✓	✓	✓	Tests required. For Level 'A' & 'B' flight simulators the maximum permissible delay is 300 milliseconds.

FLIGHT SIMULATOR STANDARDS		SIMULATOR LEVEL A	B	C	D	COMPLIANCE
r.	(continued) (1) Transport Delay: A transport delay test may be used to demonstrate that the flight simulator system response does not exceed 150 milliseconds. This test shall measure all the delay encountered by a step signal migrating from the pilot's control through the control loading electronics and interfacing through all the simulation software modules in the correct order, using a handshaking protocol, finally through the normal output interfaces to the motion system, to the visual system and instrument displays. A recordable start time for the test shall be provided by a pilot flight control input. The test mode shall permit normal computation time to be consumed and shall not alter the flow of information through the hardware/software system. The transport delay of the system is then the time between control input and the individual hardware responses. It need only be measured once in each axis. (2) Latency: The visual system, flight deck instruments and initial motion system response shall respond to abrupt pitch, roll and yaw inputs from the pilot's position within 150 milliseconds of the time, but not before the time, when the aeroplane would respond under the same conditions. The objective of the test is to compare the recorded response of the flight simulator to that of the actual aeroplane data in the take-off, cruise and landing configuration for rapid control inputs in all three rotational axes. The intent is to verify that the flight simulator system response does not exceed 150 milliseconds (this does not include aeroplane response time as per the manufacturer's data) and that the motion and visual cues relate to actual aeroplane responses. For aeroplane response, acceleration in the appropriate corresponding rotational axis is preferred.					For Level 'A' & 'B' flight simulators the maximum permissible delay is 300 milliseconds. For Level 'A' & 'B' flight simulators the maximum permissible delay is 300 milliseconds.
s.	Aerodynamic modelling shall be provided. This shall include, for aeroplanes issued an original type certificate after June 1980, low altitude level flight ground effect, Mach effect at high altitude, normal and reverse dynamic thrust effect on control surfaces, aero elastic representations, and representations of non-linearities due to sideslip based on aeroplane flight test data provided by the manufacturer.			✓	✓	Statement of Compliance required. Mach effect, aero elastic representations, and non-linearities due to sideslip are normally included in the flight simulator aerodynamic model. The Statement of Compliance shall address each of these items. Separate tests for thrust effects and a Statement of Compliance are required.

FLIGHT SIMULATOR STANDARDS	SIMULATOR LEVEL A	B	C	D	COMPLIANCE
t. Modelling that includes the effects of airframe and engine icing.			✓	✓	Statement of Compliance required. SOC shall describe the effects that provide training in the specific skills required for recognition of icing phenomena and execution of recovery.
u. Aerodynamic and ground reaction modelling for the effects of reverse thrust on directional control shall be provided.		✓	✓	✓	Statement of Compliance required. (page 2–C–44).
v. Realistic aeroplane mass properties, including mass, centre of gravity and moments of inertia as a function of payload and fuel loading shall be implemented.	✓	✓	✓	✓	Statement of Compliance required at initial evaluation. SOC 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.
w. Self-testing for flight simulator hardware and programming to determine compliance with the flight simulator performance tests shall be provided. Evidence of testing shall include flight simulator number, date, time, conditions, tolerances, and the appropriate dependent variables portrayed in comparison with the aeroplane standard.			✓	✓	Statement of Compliance required. Tests required.
x. Timely and permanent update of flight simulator hardware and programming subsequent to aeroplane modification sufficient for the Qualification Level sought.	✓	✓	✓	✓	qualification level sought.
y. Daily pre-flight documentation either in the daily log or in a location easily accessible for review is required.	✓	✓	✓	✓	

2 Motion system

FLIGHT SIMULATOR STANDARDS	SIMULATOR LEVEL A	B	C	D	COMPLIANCE
a. Motion cues as perceived by the pilot shall be representative of the aeroplane, e.g. touchdown cues shall be a function of the simulated rate of descent.	✓	✓	✓	✓	
b. A motion system shall:					Statement of Compliance required.
(1) Provide sufficient cueing, which may be of a generic nature to accomplish the required tasks.	✓				Tests required.
(2) Have a minimum of 3 degrees of freedom (pitch, roll & heave).		✓			
(3) Produce cues at least equivalent to those of a six-degrees-of-freedom synergistic platform motion system.			✓	✓	
c. A means of recording the motion response time as required.	✓	✓	✓	✓	
d. Motion effects programming shall include: (1) Effects of runway rumble, oleo deflections, groundspeed, uneven runway, centreline lights and taxiway characteristics. (2) Buffets on the ground due to spoiler/speedbrake extension and thrust reversal. (3) Bumps associated with the landing gear. (4) Buffet during extension and retraction of landing gear. (5) Buffet in the air due to flap and spoiler/speedbrake extension. (6) Approach to stall buffet.	✓	✓	✓	✓	For Level ‘A’: Effects may be of a generic nature sufficient to accomplish the required tasks.
d. (continued) (7) Touchdown cues for main and nose gear. (8) Nose wheel scuffing. (9) Thrust effect with brakes set. (10) Mach and manoeuvre buffet. (11) Tyre failure dynamics. (12) Engine malfunction and engine damage. (13) Tail and pod strike.					
e. Motion vibrations: Tests with recorded results that allow the comparison of relative amplitudes versus frequency are required. Characteristic motion vibrations that result from operation of the aeroplane in so far as vibration marks an event or aeroplane state that can be sensed at the flight deck shall be present. The flight simulator shall be programmed and instrumented in such a manner that the characteristic vibration modes can be measured and compared with aeroplane data.				✓	Statement of Compliance required. Tests required.

3 Visual System

SIMULATOR STANDARDS		SIMULATOR LEVEL A	B	C	D	COMPLIANCE
a.	The visual system shall meet all the standards enumerated as applicable to the level of qualification requested by the applicant.	✓	✓	✓	✓	
b.	Continuous minimum collimated visual field-of-view of 45 degrees horizontal and 30 degrees vertical field of view simultaneously for each pilot. Continuous, cross-cockpit, minimum collimated visual field of view providing each pilot with 180 degrees horizontal and 40 degrees vertical field of view. Application of tolerances require the field of view to be not less than a total of 176 measured degrees horizontal field of view (including not less than ±88 measured degrees either side of the centre of the design eye point) and not less than a total of 36 measured degrees vertical field of view from the pilot's and co-pilot's eye points.	✓	✓	✓	✓	. SOC is acceptable in place of this test. Consideration shall be given to optimising the vertical field of view for the respective aeroplane cut-off angle.
c.	A means of recording the visual response time for visual systems.	✓	✓	✓	✓	
d.	System Geometry. The system fitted shall be free from optical discontinuities and artefacts that create non-realistic cues.	✓	✓	✓	✓	Test required. A Statement of Compliance is acceptable in place of this test.
e.	Visual textural cues to assess sink rate and depth perception during take-off and landing shall be provided.	✓	✓	✓	✓	For Level 'A' visual cueing shall be sufficient to support changes in approach path by using runway perspective.
f.	Horizon, and attitude shall correlate to the simulated attitude indicator.	✓	✓	✓	✓	Statement of Compliance required.
g.	Occulting capability A minimum of ten levels of occulting shall be available.	✓	✓	✓	✓	Occulting shall be demonstrated. Statement of Compliance required.
h.	Surface (Vernier) resolution shall 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.			✓	✓	Test and Statement of Compliance required containing calculations confirming resolution.
i.	Surface contrast ratio shall be demonstrated by a raster drawn test pattern showing a contrast ratio of not less than 5:1			✓	✓	Test and Statement of Compliance required.
j.	Highlight brightness shall be demonstrated using a raster drawn test pattern. The highlight brightness shall not be less than 20 cd/m^2 (6ft-lamberts).			✓	✓	Test and Statement of Compliance required. Use of calligraphic lights to enhance raster brightness is acceptable.

SIMULATOR STANDARDS		SIMULATOR LEVEL A	B	C	D	COMPLIANCE
k.	Lightpoint size – not greater than 5 arc minutes.			✓	✓	Test and Statement of Compliance required. This is equivalent to a light point resolution of 2.5 arc minutes.
l.	Lightpoint contrast ratio – not less than 10:1 Light point contrast ratio – not less than 25:1.	✓	✓	✓ ✓	✓ ✓	Test and Statement of compliance required.
m.	Daylight, twilight (and night visual capability as applicable for level of qualification sought. The visual system shall be capable of meeting, as a minimum, the system brightness and contrast ratio criteria as identified in AC STD 1A.030 2.3 l. Total scene content shall be comparable in detail to that produced by 10 000 visible textured surfaces and (in day) 6 000 visible lights or (in twilight or night) 15 000 visible lights, and sufficient system capacity to display 16 simultaneously moving objects. The system, when used in training, shall provide: In daylight, full colour presentations and sufficient surfaces with appropriate textural cues to conduct a visual approach, landing and airport movement (taxi). Surface shading effects shall be consistent with simulated (static) sun position.	✓ ✓	✓ ✓	✓ ✓ ✓ ✓	✓ ✓ ✓ ✓	Statement of Compliance required for system capability. System objective and scene content tests are required.
	(ii) At twilight, as a minimum, full colour presentations of reduced ambient intensity, sufficient surfaces with appropriate textural 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). Scenes shall include a definable horizon and typical terrain characteristics such as fields, roads and bodies of water and surfaces illuminated by representative own ship lighting (e.g. landing lights). If provided, directional horizon lighting shall have correct orientation and be consistent with surface shading effects. (iii) At night, as a minimum, all features applicable to the twilight scene, as defined above, with the exception of the need to portray reduced ambient intensity that removes ground cues that are not self-illuminating or illuminated by own ship lights (e.g. landing lights).	 ✓	 ✓	✓ ✓	✓ ✓	

4 Sound System

FLIGHT SIMULATOR STANDARDS	SIMULATOR LEVEL				COMPLIANCE
	A	B	C	D	
a. Significant flight deck sounds which result from pilot actions corresponding to those of the aeroplane.	✓	✓	✓	✓	
b. Sound of precipitation, rain removal equipment and other significant aeroplane noises perceptible to the pilot during normal and abnormal operations and the sound of a crash when the simulator is landed in excess of limitations.			✓	✓	Statement of Compliance required.
c. Comparable amplitude and frequency of flight deck noises, including engine and airframe sounds. The sounds shall be co-ordinated with the required weather.				✓	Tests required.
d. The volume control shall have an indication of sound level setting which meets all qualification requirements.	✓	✓	✓	✓	

SECTION 2 – ADVISORY CIRCULARS (AC)

1 GENERAL

1.1 This Section contains Advisory Circulars (AC) providing acceptable means of compliance and/or interpretative/explanatory material that have been agreed for inclusion in YCAR–STD 1A.

1.2 Where a particular YCAR paragraph does not have an Advisory Circular (AC), it is considered that no supplementary material is required.

2 PRESENTATION

2.1 The Advisory Circulars (AC) are presented in full page width on loose pages, each page being identified by the date of issue. and the Amendment number under which it is amended or reissued.

2.2 A numbering system has been used in which the Advisory Circular (AC) uses the same number as the YCAR paragraph to which it refers. The number is introduced by the letters AC to distinguish the material from the YCAR itself.

2.3 The acronym AC also indicates the nature of the material and for this purpose the type of material is defined as follows:

Advisory Circulars (AC) illustrate a means, or several alternative means, but not necessarily the only possible means by which a requirement can be met. It should however be noted that where a new AC is developed, any such AC (which may be additional to an existing AC) will be amended into the document following consultation under the NPA procedure. Such AC will be designated by (acceptable means of compliance).

An AC as interpretative/explanatory material may contain material that helps to illustrate the meaning of a requirement. Such AC will be designated by (interpretative/explanatory material).

2.4 Explanatory Notes not forming part of the AC text appear in a smaller typeface.

2.5 New, amended or corrected text is enclosed within heavy brackets.

AC B – GENERAL

AC STD 1A.005 (acceptable means of compliance)

Terminology, Abbreviations

See YCAR–STD 1A.005

1 Terminology

1.1 In addition to the principal terms defined in the requirement itself, additional terms used in the context of YCAR–STD 1A have the following meanings:

a. Acceptable Change. A change to configuration, software etc., which qualifies as a potential candidate for alternative approach to validation.

b. Aeroplane Performance Data. Performance data published by the aeroplane manufacturer in documents such as the Aeroplane Flight Manual, Operations Manual, Performance Engineering Manual, or equivalent.

c. Audited Engineering Simulation. An aeroplane manufacturer's engineering simulation which has undergone a review by the appropriate regulatory Authorities and been found to be an acceptable source of supplemental validation data.

d. Automatic Testing. Flight Simulator testing wherein all stimuli are under computer control.

e. Baseline. A fully flight-test validation production aeroplane simulation. May represent a new aeroplane type or a major derivative.

f. Breakout. The force required at the pilot's primary controls to achieve initial movement of the control position.

g. Closed Loop Testing. A test method for which the input stimuli are generated by controllers which drive the flight simulator to follow a pre-defined target response.

h. Computer Controlled Aeroplane. An aeroplane where the pilot inputs to the control surfaces are transferred and augmented via computers.

i. Control Sweep. 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.

j. Convertible Flight Simulator. A flight simulator in which hardware and software can be changed so that the flight simulator becomes a replica of a different model or variant, usually of the same type aeroplane. The same flight simulator platform, cockpit shell, motion system, visual system, computers, and necessary peripheral equipment can thus be used in more than one simulation.

k. Critical Engine Parameter. The engine parameter which is the most appropriate measure of propulsive force.

l. Damping (critical). The CRITICAL DAMPING is 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.

m. Damping (over-damped). An OVER-DAMPED response is that 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.

n. Damping (under-damped). An UNDER-DAMPED response is that 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.

o. Daylight Visual. A visual system capable of meeting, as a minimum, system brightness, contrast ratio requirements and performance criteria appropriate for the level of qualification sought. The system, when used in training, should provide full colour presentations and sufficient surfaces with appropriate textural cues to successfully conduct a visual approach, landing and airport movement (taxy).

p. Deadband. 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.

q. Driven. A state where the input stimulus or variable is ‘driven’ or deposited by automatic means, generally a computer input. The input stimulus or variable may not necessarily be an exact match to the flight test comparison data – but simply driven to certain predetermined values.

r. Engineering Simulation. An integrated set of mathematical models representing a specific aeroplane configuration, which is typically used by the aeroplane manufacturer for a wide range of engineering analysis tasks including engineering design, development and certification: and to generate data for checkout, proof-of-match/validation and other training flight simulator data documents.

s. Engineering Simulator. The term for the aeroplane manufacturer’s flight simulator which typically includes a full-scale representation of the simulated aeroplane flight deck, operates in real time and can be flown by a pilot to subjectively evaluate the simulation. It contains the engineering simulation models, which are also released by the aeroplane manufacturer to the industry for training flight simulators: and may or may not include actual on-board system hardware in lieu of software models.

t. Engineering Simulator Data. Data generated by an engineering simulation or engineering flight simulator, depending on the aeroplane manufacturer’s processes.

u. Engineering Simulator Validation Data. Validation data generated by an engineering simulation or engineering simulator.

v. Entry into Service. Refers to the original state of the configuration and systems at the time a new or major derivative aeroplane is first placed into commercial operation.

w. Essential Match. A comparison of two sets of computer-generated results for which the differences should be negligible because essentially the same simulation models have been used. Also known as a virtual match.

x. Evaluation. The careful appraisal of a flight simulator by the authority to ascertain whether or not the standards required for a specified Qualification Level are met.

y. Flight Simulator Approval. The extent to which a flight simulator of a specified Qualification Level may be used by an operator or training organisation as agreed by the Authority. It takes account of differences between aeroplanes and flight simulators and the operating and training ability of the organisation.

z. Flight Simulator Data. The various types of data used by the flight simulator manufacturer and the applicant to design, manufacture, test and maintain the flight simulator.

aa. Flight Simulator Operator. That person, organisation or enterprise directly responsible to the authority for requesting and maintaining the qualification of a particular flight simulator.

bb. Flight Test Data. Actual aeroplane data obtained by the aeroplane manufacturer (or other supplier of acceptable data) during an aeroplane flight test programme.

cc. Flight Simulator Qualification Level. The level of technical capability of a flight simulator.

dd. Free Response. The response of the aeroplane after completion of a control input or disturbance.

ee. Full Sweep. 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.

ff. Functional Performance. An operation or performance that can be verified by objective data or other suitable reference material that may not necessarily be flight test data.

gg. Functions Test. A quantitative assessment of the operation and performance of a Flight Simulator by a suitably qualified evaluator. The test can include verification of correct operation of controls, instruments, and systems of the simulated aeroplane under normal and non-normal conditions. Functional performance is that operation or performance that can be verified by objective data or other suitable reference material which may not necessarily be flight test data.

hh. (reserved)

ii. Ground Effect. The change in aerodynamic characteristics due to modification of the air flow past the aircraft caused by the presence of the ground.

jj. Hands-off Manoeuvre. A test manoeuvre conducted or completed without pilot control inputs.

kk. Hands-on Manoeuvre. A test manoeuvre conducted or completed with pilot control inputs as required.

ll. Highlight Brightness. The area of maximum displayed brightness, which satisfies the brightness test appropriate for the level of qualification sought.

mm. Icing Accountability. Refers to changes from normal (as applicable to the individual aeroplane design) in takeoff, climb (enroute, 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.

nn. Integrated Testing. Testing of the flight simulator such that all aeroplane system models are active and contribute appropriately to the results. None of the aeroplane 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.

oo. Irreversible Control System. A control system in which movement of the control surface will not backdrive the pilot's control in the cockpit.

pp. Latency. The additional time, beyond that of the basic perceivable response time of the aeroplane due to the response time of the flight simulator.

qq. Line Oriented Flight Training (LOFT). Refers to aircrew 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.

rr. Manual Testing. Flight simulator testing wherein the pilot conducts the test without computer inputs except for initial setup. All modules of the simulation should be active.

ss. Master Qualification Test Guide (MQTG). The Authority approved QTG which incorporates the results of tests witnessed by the Authority. The MQTG serves as the reference for future evaluations.

tt. Night Visual. 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, 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 own ship lights (e.g. landing lights).

uu. Non-normal Control. A state where one or more of the intended control, augmentation or protection functions are not fully available. Used in reference to computer controlled aeroplanes.

(Note: Specific terms such as ALTERNATE, DIRECT, SECONDARY, BACKUP, etc, may be used to define an actual level of degradation).

vv. Normal Control. A state where the intended control, augmentation and protection functions are fully available. Used in reference to computer controlled aeroplanes.

ww. Objective Test (Objective Testing). A quantitative assessment based on comparison with data.

xx. One Step. Refers to the degree of changes to an aeroplane 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 which 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'.

yy. Operator. A person, organisation or enterprise engaging in or offering to engage in an aeroplane operation.

zz. Proof-of-Match (POM). A document which shows agreement within defined tolerances between model responses and flight test cases at identical test and atmospheric conditions.

aaa. Protection Functions. Systems functions designed to protect an aeroplane from exceeding its flight and manoeuvre limitations.

bbb. Pulse Input. An abrupt input to a control followed by an immediate return to the initial position.

ccc. Qualification Test Guide (QTG). The primary reference document used for the evaluation of a flight simulator. It contains test results, statements of compliance and other information to enable the evaluator to assess if the flight simulator meets the test criteria described in this manual.

ddd. Reversible Control System. A control system in which movement of the control surface will backdrive the pilot's control on the flight deck.

eee. Robotic Test. 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.

fff. Snapshot. A presentation of one or more variables at a given instant of time.

ggg. Statement of Compliance (SOC). A declaration that specific requirements have been met.

hhh. Step Input. An abrupt input held at a constant value.

iii. Subjective Test (Subjective Testing). A qualitative assessment based on established standards as interpreted by a suitably qualified person.

jjj. Throttle Lever Angle. The angle of the pilot's primary engine control lever(s) on the flight deck, which also may be referred to as TLA or power lever or throttle.

kkk. Time History. A presentation of the change of a variable with respect to time.

lll. Transport Delay. The total flight simulator system processing time between an input signal from a pilot primary flight control and 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 aeroplane simulated.

mmm. Twilight (Dusk/Dawn) Visual. 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)

nnn. Update. The improvement or enhancement of a flight simulator.

ooo. Upgrade. An update for the purpose of achieving a higher qualification.

ppp. Validation Data. Data used to prove that the flight simulator performance corresponds to that of the aeroplane.

qqq. Validation Flight Test Data. Performance, stability and control, and other necessary test parameters electrically or electronically recorded in an aeroplane using a calibrated data acquisition system of sufficient resolution and verified as accurate by the organisation performing the test to establish a reference set of relevant parameters to which like flight simulator parameters can be compared.

rrr. Validation Test. A test by which flight simulator parameters can be compared with the relevant validation data.

sss. Visual System Response Time. 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.

ttt. Visual Ground Segment Test. A test designed to assess items impacting the accuracy of the visual scene presented to the pilot at a decision height (DH) on an ILS approach.

uuu. Well-Understood Effect. An incremental change to a configuration or system which can be accurately modelled using proven predictive methods based on known characteristics of the change.

2 Abbreviations

AC	=	Advisory Circular
AC	=	Advisory Circular
AFM	=	Approved Flight Manual
AGL	=	Above Ground Level (metres or feet)
Airspeed	=	Calibrated airspeed unless otherwise specified (knots)
Altitude	=	Pressure altitude (metres or feet) unless specified otherwise
AOA	=	Angle of Attack (degrees)
A_d	=	Total initial displacement of pilot controller (initial displacement to final resting amplitude)
A_n	=	Sequential amplitude of overshoot after initial X axis crossing, e.g. A_1 = 1st overshoot.
Bank	=	Bank/Roll angle (degrees)
BC	=	ILS localizer back course

CAT I/II/III	=	Landing category operations
CCA	=	Computer Controlled Aeroplane
cd/m^2	=	candela/metre^2, 3·4263 candela/m^2 = 1 ft-Lambert
cm(s)	=	centimetre, centimetres
daN	=	decaNewtons
deg(s)	=	degree, degrees
DH	=	Decision Height
distance	=	distance in Nautical Miles unless specified otherwise
DME	=	Distance Measuring Equipment
EPR	=	Engine Pressure Ratio
FAA	=	United States Federal Aviation Administration (U.S.)
ft	=	feet, 1 foot = 0·304801 metres
ft-Lambert	=	foot-Lambert, 1 ft-Lambert = 3·4263 candela/m^2
fuel used	=	Mass of fuel used (kilos or pounds)
g	=	Acceleration due to gravity (metres or feet/sec^2), 1g = 9·81 m/sec^2 or 32·2 feet/sec^2
G/S	=	Glideslope
GPS	=	Global Positioning System
HGS	=	Head-up Guidance System
Heavy	=	Operational mass at or near the maximum for the specified flight condition
Height	=	Height above ground = AGL (metres or feet)
IATA	=	International Air Transport Association
ICAO	=	International Civil Aviation Organisation
ILS	=	Instrument Landing System
IOS	=	Instructor Operating Station
IPOM	=	Integrated proof of match
JAA	=	Joint Aviation Authorities
YCAR	=	Civil Aviation Regulation
JAWS	=	Joint Airport Weather Studies
km	=	Kilometres 1 km = 0·62137 Statute Miles
kPa	=	KiloPascal (Kilo Newton/Metres^2). 1 psi = 6·89476 kPa
kts	=	Knots calibrated airspeed unless otherwise specified, 1 Knot = 0·5148 m/sec or 1·689 ft/sec
lb	=	pounds
light	=	Operational mass at or near the minimum for the specified flight condition
LOC	=	ILS localizer
LOFT	=	Line oriented flight training
LOS	=	Line oriented simulation
m	=	Metres, 1 Metre = 3·28083 feet
MCC	=	Multi-Crew Co-operation
MCTM	=	Maximum certificated take-off mass (kilos/pounds)
Medium	=	Normal operational weight for flight segment
min	=	Minutes
MLG	=	Main landing gear
MPa	=	MegaPascals 1 psi = 6894·76 pascals
MQTG	=	Master Qualification Test Guide
ms	=	millisecond(s)
N	=	NORMAL CONTROL Used in reference to Computer Controlled Aeroplanes
n	=	sequential period of a full cycle of oscillation
N1	=	Engine Low Pressure Rotor revolutions per minute expressed in percent of maximum
N2	=	Engine High Pressure Rotor revolutions per minute expressed in percent of maximum
NAA	=	National Aviation Authority
NDB	=	Non-directional beacon
NM	=	Nautical Mile, 1 Nautical Mile = 6 080 feet = 1 852m
NN	=	Non-normal control a state referring to computer controlled aeroplanes

Nominal = Normal operational weight, configuration, speed, etc, for the flight segment specified
NWA = Nosewheel Angle (degrees)

OM-B = Operations Manual – Part B (AFM)

PANS = Procedure for air navigation services
PAPI = Precision Approach Path Indicator System
PAR = Precision approach radar
Pitch = Pitch angle (degrees)
P_0 = Time from pilot controller release until initial X axis crossing (X axis defined by the resting amplitude)
P_1 = First full cycle of oscillation after the initial X axis crossing
P_2 = Second full cycle of oscillation after the initial X axis crossing
P_n = Sequential period of oscillation
P_f = Impact or Feel Pressure
PLF = Power for Level Flight
POM = Proof-of-Match
PSD = Power Spectral Density
psi = pounds per square inch

QTG = Qualification Test Guide

RAE = Royal Aerospace Establishment
RAeS = Royal Aeronautical Society
REIL = Runway End Identifier Lights
R/C = Rate of Climb (metres/sec or feet/min)
R/D = Rate of Descent (metres/sec or feet/min)
RNAV = Radio navigation
RVR = Runway Visual Range (metres or feet)

s = second(s)
sec(s) = second, seconds
Sideslip = Sideslip Angle (degrees)
sm = Statute Mile 1 Statute Mile = 5 280 feet = 1 609m
SOC = Statement of Compliance
STD = Synthetic Training Device
SUPPS = Supplementary procedures referring to regional supplementary procedures

T(A) = Tolerance applied to Amplitude
TLA = Throttle lever angle
T(p) = Tolerance applied to period
T/O = Take-off
T_f = Total time of the flare manoeuvre duration
T_i = Total time from initial throttle movement until a 10% response of a critical engine parameter
T_t = Total time from T_i to a 90% increase or decrease in the power level specified

VASI = Visual Approach Slope Indicator System
VDR = Validation Data Roadmap
VFR = Visual Flight Rules
VGS = Visual Ground Segment
V_{MCA} = Minimum Control Speed (Air)
V_{MCG} = Minimum Control Speed (Ground)
V_{MCL} = Minimum Control Speed (Landing)
VOR = VHF omni-directional range
V_R = Rotate Speed
V_S = Stall Speed or minimum speed in the stall

WAT = Weight, Altitude, Temperature
1st Segment = That portion of the take-off profile from lift-off to completion of gear retraction
2nd Segment = That portion of the take-off profile from after gear retraction to end of climb at V2 and initial flap/slat retraction
3rd Segment = That portion of the take-off profile after flap/slat retraction is complete

AC No. 1 to YCAR-STD 1A.015 (acceptable means of compliance)

AC C – AEROPLANE FLIGHT SIMULATORS

Flight Simulator Qualification – Application and Inspection
See YCAR–STD 1A.015

1. **LETTER OF APPLICATION FOR INITIAL EVALUATION OF FLIGHT SIMULATOR**

Part A

To Be Submitted Not Less Than 3 Months Prior To Requested Qualification Date

(Date)
PRINCIPAL INSPECTOR
(AAAA OFFICE)
(Address)

(City)

(Country)

Dear ,

.......…..........(Name of applicant).........…..…....... requests the evaluation of its ……..(type)…… flight simulator for level ……..…......(A,B,C or D) qualification. The flight simulator manufacturer is…………………………………………and the visual system manufacturer ………………………….... Dates requested are:……………………….. and the flight simulator will be located at ……………………………

Evaluation is requested for the following configurations and engine fits:
e.g. 767 PW/GE and 757RR
1……………..
2…………….
3…………….

The QTG will be submitted by……(Date)………… and in any event not less than 30 days before the requested evaluation date unless otherwise agreed with the Authority.

Comments:
………
………
………………………………………

Signed

………………………
Print name……………..
position/appointment held……………….
e mail address…………….
telephone number………..

(Date)

Part B

To Be Completed With Attached QTG Results

We have completed tests of the flight simulator and declare that it meets all applicable requirements of YCAR–STD 1A (Aeroplane Flight Simulators) except as noted below.

The following tests are outstanding:

Tests	Comments

Add boxes as required

Signed

………………………

Print name
position/appointment held………………
e mail address……………
telephone number…………

Part C

To Be Completed Not Less Than 7 Days Prior To Initial Evaluation

The flight simulator has been assessed by the following evaluation team:

(name)	Qualification
(name)	Qualification
(name)	Qualification
(name)	Pilot's Licence Nr................
(name).	Flight Engineer (Licence Nr) – if applicable

This team attest(s) that the flight simulator conforms to the aeroplane cockpit configuration of ……………........(Name of Operator)…….........(type of aeroplane)……..... aeroplane and that the simulated systems and subsystems function equivalently to those in that aeroplane. This pilot has also assessed the performance and the flying qualities of the flight simulator and finds that it represents the designated aeroplane.

Additional comments as required:

Signed

………………………
Print name……………..
position/appointment held……………….
e mail address…………….
telephone number…………

2 Composition of Evaluation Team

2.1 To gain a Qualification Level, a flight simulator is evaluated in accordance with a structured routine conducted by a technical team which is appointed by the Authority and normally consists of at least:

a. A technical flight simulator inspector of the Authority, or an accredited inspector from another Authority, qualified in all aspects of flight simulation hardware, software and computer modelling or, exceptionally, a person designated by the Authority with equivalent qualifications; and

b. One of the following:

i. A flight inspector of the Authority, or an accredited inspector from another Authority, who is qualified in flight crew training procedures and type rated on the aeroplane being simulated; or

ii. A flight inspector of the Authority who is qualified in flight crew training procedures assisted by a type rating instructor, type rated on the aeroplane being simulated; or, exceptionally,

iii. A person designated by the Authority who is qualified in flight crew training procedures and type rated on the aeroplane being simulated.

Where a designee is used as a substitute for one of the Authority's inspectors, the other person shall be a properly qualified inspector of the Authority or an accredited inspector from another Authority.

2.2 Additionally the following persons should be present:

a. A type rated Training Captain typically from the STD operator or main flight simulator users.

b. Sufficient flight simulator support staff to assist with the running of tests and operation of the instructor's station.

2.3 On a case-by-case basis, the Authority may reduce the evaluation team to an Authority flight inspector supported by a type rated training captain from the main flight simulator user for evaluation of a specific flight simulator of a specific STD operator, provided:

a. This composition is not being used prior to the second recurrent evaluation;

b. Such an evaluation will be followed by an evaluation with a full authority evaluation team;

c. The Authority flight inspector will perform some spot checks in the area of objective testing;

d. No major change or upgrading has been applied since the directly preceding evaluation;

e. No relocation of the flight simulator has taken place since the last evaluation;

f. A system is established enabling the Authority to monitor and analyse the status of the flight simulator on a continuous basis;

g. The flight simulator's hard– and software has been working reliably for the previous years. This should be reflected in the number and kind of (technical log) discrepancies and the results of the quality system audits.

AC No. 2 to YCAR-STD 1A.015 (explanatory material)
Flight Simulator Evaluations
See YCAR–STD 1A.015

1 General

1.1 During initial and recurrent flight simulator evaluations it will be necessary for the Authority to conduct the objective and subjective tests described in YCAR–STD 1A.030 and YCAR–STD 1A.035, and detailed in AC STD 1A.030. There will be occasions when all tests cannot be completed – for example during recurrent evaluations on a convertible flight simulator – but arrangements should be made for all tests to be completed within a reasonable time.

1.2 Following an evaluation, it is possible that a number of defects may be identified, generally these defects should be rectified and the Authority notified of such action within 30 days. Serious defects, affecting flight crew training, testing and checking, could result in an immediate downgrading of the Qualification Level, or if any defect remains unattended without good reason for period greater than 30 days, subsequent downgrading may occur.

2 Initial Evaluations

2.1 Objective Testing

2.1.1 Objective testing is centred around the QTG. Before testing can begin on an initial evaluation the acceptability of the validation tests contained in the QTG should be agreed with the Authority well in advance of the evaluation date to ensure that the flight simulator time especially devoted to the running of some of the tests by the Authority is not wasted. The acceptability of all tests depends upon their content, accuracy, completeness and recency of the results.

2.1.2 Much of the time allocated to objective tests depends upon the speed of the automatic and manual systems set up to run each test and whether or not special equipment is required. The Authority will not necessarily warn the STD operator of the sample validations tests which will be run on the day of the evaluation, unless special equipment is required. It should be remembered that the flight simulator cannot be used for subjective tests whilst part of the QTG is being run. Therefore at least a complete working day (i.e. at least 8 consecutive hours) should be set aside for the examination and running of the QTG. A useful explanation of how the validation tests should be run is contained in the 'Aeroplane Flight Simulator Evaluation Handbook' (February 95 or as amended) produced in support of the ICAO Manual of criteria for the qualification of flight simulators and YCAR–STD 1A.

2.2 Subjective Testing

2.2.1 The subjective tests for the evaluation can be found in AC STD 1A.030, and a suggested subjective test profile is described in sub-paragraph 4 below.

2.2.2 Essentially one working day is required for the subjective test routine, which effectively denies use of the flight simulator for any other purpose.

2.3 Conclusion

2.3.1 To ensure adequate coverage of subjective and objective tests and to allow for cost effective rectification and retest before departure of the inspection team, three consecutive days should be dedicated to an initial evaluation of a flight simulator.

3 Recurrent Evaluations

3.1 Objective Testing

3.1.1 During recurrent evaluations, the Authority will wish to see evidence of the successful running of the QTG between evaluations. The Authority will select a number of tests to be run during the evaluation, including those which may be cause for concern, giving adequate notification if special equipment is required.

3.1.2 Essentially the time taken to run the objective tests depends upon the need for special equipment and the test system, and the flight simulator cannot be used for subjective tests or other functions whilst

testing is in progress. For a modern flight simulator incorporating an automatic test system, four (4) hours would normally be required. Flight simulators which rely upon manual testing may require a longer period of time.

3.2 Subjective Testing

3.2.1 Essentially the same subjective test routine should be flown as per the profile described in sub-paragraph 4.6 below with a selection of the subjective tests taken from AC STD 1A.030.

3.2.2 Normally, the time taken for recurrent subjective testing is about 4 hours, and the flight simulator cannot perform other functions during this time.

3.3 Conclusion

3.3.1 To ensure adequate coverage of subjective and objective tests during a recurrent evaluation, a total of 8 hours should be allocated. However, it should be remembered that any flight simulator deficiency which arises during the evaluation could necessitate the extension of the evaluation period.

4 Functions and Subjective Tests – Suggested Test Routine

4.1 During initial and recurrent evaluations of a flight simulator, the Authority will conduct a series of functions and subjective tests which together with the objective tests complete the comparison of the flight simulator with the aeroplane.

4.2 Whereas functions tests verify the acceptability of the simulated aeroplane systems and their integration, subjective tests verify the fitness of the flight simulator in relation to training, checking and testing tasks.

4.3 The flight simulator should provide adequate flexibility to permit the accomplishment of the desired/required tasks while maintaining an adequate perception by the flight crew that they are operating in a real aeroplane environment. Additionally, the Instructor Operating Station (IOS) should not present an unnecessary distraction from observing the activities of the flight crew whilst providing adequate facilities for the tasks.

4.4 Section One of YCAR–STD 1A prescribes the requirements and the ACs in Section Two the means of compliance for flight simulator qualification. However, it is important that both the Authority and the STD operator understand what to expect from the routine of flight simulator functions and subjective tests. It should be remembered that part of the subjective tests routine should involve an uninterrupted fly-out comparable with the duration of typical training sessions in addition to assessment of flight freeze and repositioning. An example of such a profile is to be found in Figure 1 below. A useful explanation of functions and subjective tests and an example of subjective test routine check-list are to be found in the Airplane Flight Simulator Evaluation Handbook (February 95 or as amended) produced in support of the ICAO Manual of criteria for the qualification of flight simulators and YCAR–STD 1A.

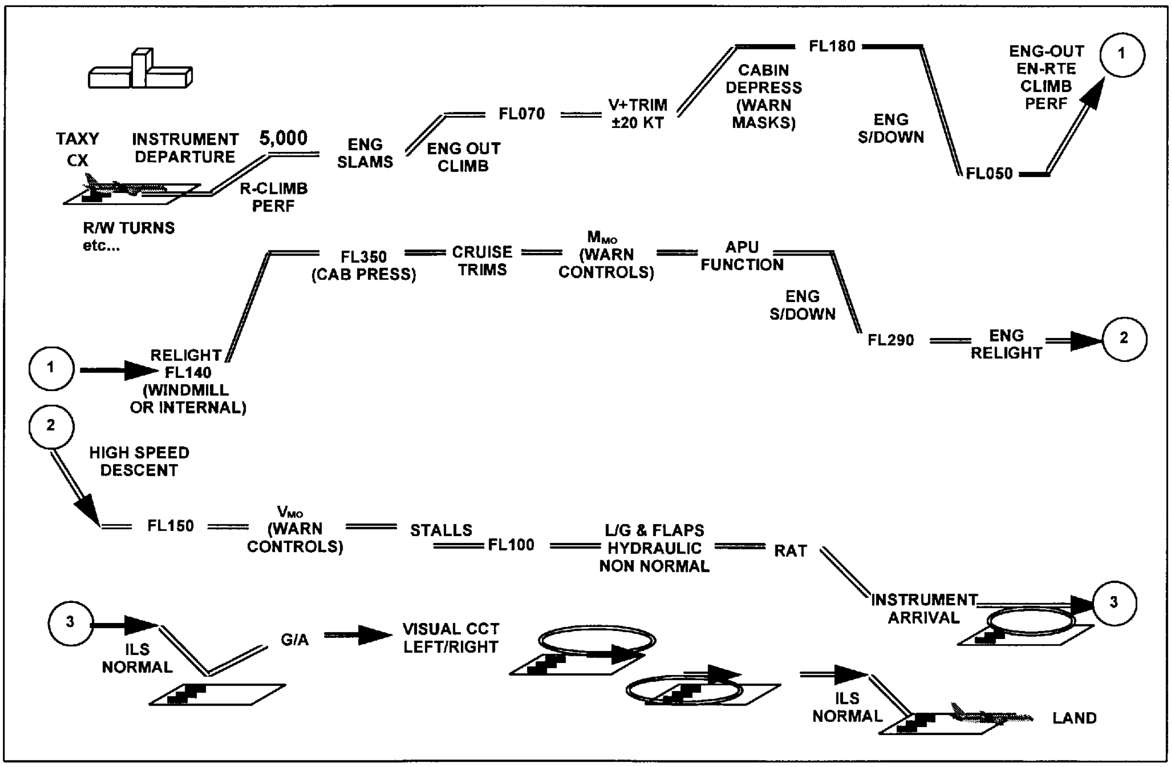

Figure 1 – Typical Test Profile (2 hours)

4.5 Authorities and STD operators who are unfamiliar with the evaluation process are advised to contact the AAAA.

AC STD 1A.020(a) (acceptable means of compliance)
Validity of Flight Simulator Qualification
See YCAR-STD 1A.020

1. Prerequisites

1.1 On a case-by-case basis, the Authority may grant an extended validity of a flight simulator qualification in excess of 12 months up to a maximum of 36 months, to a specific STD operator for a specific flight simulator, provided:

a. an initial and at least one recurrent successful evaluation have been performed on this flight simulator by the same Authority;

b. the STD operator has got a satisfactory record of successful regulatory flight simulator evaluations over a period of at least 3 years;

c. the STD operator has established and successfully maintained a Quality System for at least 3 years;

d. the Authority performs a formal audit of the STD operator's Quality System every calendar year;

e. an accountable person of the STD operator with flight simulator and training experience acceptable to the Authority (such as a type rated training captain), reviews the regular reruns of the QTG and conducts the relevant function and subjective tests every 12 months;

f. a report detailing the results of the QTG rerun tests and function and subjective evaluation will be signed and submitted by the accountable person described under subparagraph (e) above to the Authority.

2. Prerogative of the Authority

The Authority reserves the right to perform flight simulator evaluations whenever it deems it necessary.

ACSTD 1A.025 (acceptable means of compliance)

Quality System

See YCAR–STD 1A.025

1 Introduction

1.1 In order to show compliance with YCAR–STD 1A.025, an STD operator should establish his Quality System in accordance with the instructions and information contained in the following paragraphs.

2 General

2.1 Terminology

a. The terms used in the context of the requirement for an STD operator's Quality System have the following meanings:

i. *Accountable Manager.* The person acceptable to the Authority who has corporate authority for ensuring that all necessary activities can be financed and carried out to the standard required by the Authority, and any additional requirements defined by the STD operator.

ii. *Quality Assurance.* All those planned and systematic actions necessary to provide adequate confidence that specified performance, functions and characteristics satisfy given requirements.

iii. *Quality Manager.* The manager, acceptable to the Authority, responsible for the management of the Quality System, monitoring function and requesting corrective actions.

2.2 Quality Policy

2.2.1 An STD operator should establish a formal written Quality Policy Statement that is a commitment by the Accountable Manager as to what the Quality System is intended to achieve. The Quality Policy should reflect the achievement and continued compliance with YCAR–STD 1A together with any additional standards specified by the STD operator.

2.2.2 The Accountable Manager is an essential part of the STD qualification holder's organisation. With regard to the above terminology, the term 'Accountable Manager' is intended to mean the Chief Executive/President/Managing Director/General Manager etc. of the STD operator's organisation, who by virtue of his position has overall responsibility (including financial) for managing the organisation.

2.2.3 The Accountable Manager will have overall responsibility for the STD qualification holder's Quality System including the frequency, format and structure of the internal management evaluation activities as prescribed in paragraph 4.9 below.

2.3 Purpose of the Quality System

2.3.1 The Quality System should enable the STD operator to monitor compliance with YCAR–STD 1A, and any other standards specified by that STD operator, or the Authority, to ensure correct maintenance and performance of the device.

2.4 Quality Manager

2.4.1 The primary role of the Quality Manager is to verify, by monitoring activity in the fields of STD qualification, that the standards required by the Authority, and any additional requirements defined by the STD operator, are being carried out under the supervision of the relevant Manager.

2.4.2 The Quality Manager should be responsible for ensuring that the Quality Assurance Programme is properly established, implemented and maintained.

2.4.3 The Quality Manager should:

a. Have direct access to the Accountable Manager;

b. Have access to all parts of the STD operator's and, as necessary, any sub-contractor's organisation.

2.4.4 The posts of the Accountable Manager and the Quality Manager may be combined by STD operators whose structure and size may not justify the separation of those two posts. However, in this event, Quality Audits should be conducted by independent personnel.

3 Quality System

3.1 Introduction

3.1.1 The STD operator's Quality System should ensure compliance with STD qualification requirements, standards and procedures.

3.1.2 The STD operator should specify the structure of the Quality System.

3.1.3 The Quality System should be structured according to the size and complexity of the organisation to be monitored.

3.2 Scope

3.2.1 As a minimum, the Quality System should address the following:

a. The provision of YCAR–STD 1A.

b. The STD operator's additional standards and procedures.

c. The STD operator's Quality Policy.

d. The STD operator's organisational structure.

e. Responsibility for the development, establishment and management of the Quality System.

f. Documentation, including manuals, reports and records.

g. Quality Procedures.

h. Quality Assurance Programme.

i. The provision of adequate financial, material and human resources.

j. Training requirements for the various functions in the organisation.

3.2.2 The Quality System should include a feedback system to the Accountable Manager to ensure that corrective actions are both identified and promptly addressed. The feedback system should also specify who is required to rectify discrepancies and non-compliance in each particular case, and the procedure to be followed if corrective action is not completed within an appropriate timescale.

3.3 Relevant Documentation

3.3.1 Relevant documentation should include the following:

a. Quality Policy.

b. Terminology.

c. Reference to specified STD technical standards.

d. A description of the organisation.

e. The allocation of duties and responsibilities.

f. Qualification procedures to ensure regulatory compliance.

g. The Quality Assurance Programme, reflecting:

i. Schedule of the monitoring process.

ii. Audit procedures.

iii. Reporting procedures.

iv. Follow-up and corrective action procedures.

v. Recording system.

h. Document control.

4 Quality Assurance Programme

4.1 Introduction

4.1.1 The Quality Assurance Programme should include all planned and systematic actions necessary to provide confidence that all maintenance is conducted and all performance maintained in accordance with all applicable requirements, standards and procedures.

4.1.2 When establishing a Quality Assurance Programme, consideration should, at least, be given to the paragraphs 4.2 to 4.9 below.

4.2 Quality Inspection

4.2.1 The primary purpose of a quality inspection is to observe a particular event/action/document etc., in order to verify whether established procedures and requirements are followed during the accomplishment of that event and whether the required standard is achieved.

4.2.2 Typical subject areas for quality inspections are:

a. Actual STD operation.

b. Maintenance.

c. Technical standards.

d. Flight simulator safety features.

4.3 Audit

4.3.1 An audit is a systematic and independent comparison of the way in which an activity is being conducted against the way in which the published procedures say it should be conducted.

4.3.2 Audits should include at least the following quality procedures and processes:

a. A statement explaining the scope of the audit.

b. Planning and preparation.

c. Gathering and recording evidence; and

d. Analysis of the evidence.

4.3.3 Techniques which contribute to an effective audit are:

a. Interviews or discussions with personnel.

b. A review of published documents.

c. The examination of an adequate sample of records.

d. The witnessing of the activities which make up the operation; and

e. The preservation of documents and the recording of observations.

4.4 Auditors

4.4.1 An STD operator should decide, depending on the complexity and size of the organisation, whether to make use of a dedicated audit team or a single auditor. In any event, the auditor or audit team should have relevant STD experience.

4.4.2 The responsibilities of the auditors should be clearly defined in the relevant documentation.

4.5 Auditor's Independence

4.5.1 Auditors should not have any day to day involvement in the area of activity which is to be audited. An STD operator may, in addition to using the services of full-time dedicated personnel belonging to a separate quality department, undertake the monitoring of specific areas or activities by the use of part-time auditors. Due to the technological complexity of flight simulators and other STDs, which requires auditors with very specialised knowledge and experience, an STD operator may undertake the audit function by the use of part-time personnel from within his own organisation or from an external source under the terms of an agreement acceptable to the Authority. In all cases the STD operator should develop suitable procedures to ensure that persons directly responsible for the activities to be audited are not selected as part of the auditing team. Where external auditors are used, it is essential that any external specialist is familiar with the type of device conducted by the STD operator.

4.5.2 The STD operator's Quality Assurance Programme should identify the persons within the company who have the experience, responsibility and authority to:

a. Perform quality inspections and audits as part of ongoing Quality Assurance.

b. Identify and record any concerns or findings, and the evidence necessary to substantiate such concerns or findings.

c. Initiate or recommend solutions to concerns or findings through designated reporting channels.

d. Verify the implementation of solutions within specific time scales.

e. Report directly to the Quality Manager.

4.6 Audit Scope

4.6.1 STD operators are required to monitor compliance with the procedures they have designed to ensure specified performance and functions. In doing so they should as a minimum, and where appropriate, monitor:

a. Organisation.

b. Plans and objectives.

c. Maintenance procedures.

d. STD Qualification Level.

e. Supervision.

f. STD technical status.

g. Manuals, logs, and records.

h. Defect deferral.

i. Personnel training.

j. Aeroplane modifications management.

4.7 Auditing scheduling

4.7.1 A Quality Assurance Programme should include a defined audit schedule and a periodic review. The schedule should be flexible, and allow unscheduled audits when trends are identified. Follow-up audits should be scheduled when necessary to verify that corrective action was carried out and that it was effective.

4.7.2 An STD operator should establish a schedule of audits to be completed during a specified calendar period. All aspects of the operation should be reviewed within every period of 12 months in accordance with the programme unless an extension to the audit period is accepted as explained below. An STD operator may increase the frequency of audits at his discretion but should not decrease the frequency without the agreement of the Authority.

4.7.3 When an STD operator defines the audit schedule, significant changes to the management, organisation, or technologies should be considered as well as changes to the regulatory requirements.

4.7.4 For STD operators whose structure and size may not justify the completion of a complex system of audits, it may be appropriate to develop a Quality Assurance Programme that employs a checklist. The checklist should have a supporting schedule that requires completion of all checklist items within a specified time scale, together with a statement acknowledging completion of a periodic review by top management.

4.7.5 Whatever arrangements are made, the STD operator retains the ultimate responsibility for the Quality System and especially the completion and follow up of corrective actions.

4.8 Monitoring and Corrective Action

4.8.1 The aim of monitoring within the Quality System is primarily to investigate and judge its effectiveness and thereby to ensure that defined policy, performance and function standards are continuously complied with. Monitoring activity is based upon quality inspections, audits, corrective action and follow-up. The STD operator should establish and publish a quality procedure to monitor regulatory compliance on a continuing basis. This monitoring activity should be aimed at eliminating the causes of unsatisfactory performance.

4.8.2 Any non-compliance identified as a result of monitoring should be communicated to the manager responsible for taking corrective action or, if appropriate, the Accountable Manager. Such non-compliance should be recorded, for the purpose of further investigation, in order to determine the cause and to enable the recommendation of appropriate corrective action.

4.8.3 The Quality Assurance Programme should include procedures to ensure that corrective actions are taken in response to findings. These quality procedures should monitor such actions to verify their effectiveness and that they have been completed. Organisational responsibility and accountability for the implementation of corrective actions resides with the department cited in the report identifying the finding. The Accountable Manager will have the ultimate responsibility for resourcing the corrective action and ensuring, through the Quality Manager, that the corrective action has re-established compliance with the standard required by the Authority, and any additional requirements defined by the STD operator.

4.8.4 Corrective action

a. Subsequent to the quality inspection/audit, the STD operator should establish:

i. The seriousness of any findings and any need for immediate corrective action.

ii. Cause of the finding.

iii. Corrective actions required to ensure that the non-compliance does not recur.

iv. A schedule for corrective action.

v. The identification of individuals or departments responsible for implementing corrective action.

vi. Allocation of resources by the Accountable Manager, where appropriate.

4.8.5 The Quality Manager should:

a. Verify that corrective action is taken by the manager responsible in response to any finding of non-compliance.

b. Verify that corrective action includes the elements outlined in paragraph 4.8.4 above.

c. Monitor the implementation and completion of corrective action.

d. Provide management with an independent assessment of corrective action, implementation and completion.

e. Evaluate the effectiveness of corrective action through the follow-up process.

4.9 Management Evaluation

4.9.1 A management evaluation is a comprehensive, systematic, documented review of the Quality System and procedures by the management, and it should consider:

a. The results of quality inspections, audits and any other indicators.

b. The overall effectiveness of the management organisation in achieving stated objectives.

4.9.2 A management evaluation should identify and correct trends, and prevent, where possible, future non-conformities. Conclusions and recommendations made as a result of an evaluation should be submitted in writing to the responsible manager for action. The responsible manager should be an individual who has the authority to resolve issues and take action.

4.9.3 The Accountable Manager should decide upon the frequency, format, and structure of internal management evaluation activities.

4.10 Recording

4.10.1 Accurate, complete, and readily accessible records documenting the results of the Quality Assurance Programme should be maintained by the STD operator. Records are essential data to enable an STD operator to analyse and determine the root causes of non-conformity, so that areas of non-compliance can be identified and addressed.

4.10.2 The following records should be retained for a period of 5 years:

a. Audit schedules.

b. Quality inspection and audit reports.

c. Response to findings.

d. Corrective action reports.

e. Follow-up and closure reports; and

f. Management evaluation reports.

5 Quality Assurance responsibility for sub-contractors

5.1 Sub-contractors

5.1.1 STD operators may decide to sub-contract out certain activities to external agencies for the provision of services related to areas such as:

a. Maintenance.

b. Manual preparation.

5.1.2 The ultimate responsibility for the product or service provided by the sub-contractor always remains with the STD operator. A written agreement should exist between the STD operator and the sub-contractor clearly defining the services and quality to be provided. The sub-contractor's quality related activities should be included in the STD operator's Quality Assurance Programme.

5.1.3 The STD operator should ensure that the sub-contractor has the necessary authorisation/approval when required, and commands the resources and competence to undertake the task. If the STD operator requires the sub-contractor to conduct activity which exceeds the sub-contractor's authorisation/approval, the STD operator is responsible for ensuring that the sub-contractor's Quality Assurance takes account of such additional requirements.

6 Quality System Training

6.1 General

6.1.1 An STD operator should establish effective, well planned and resourced quality related briefing for all personnel.

6.1.2 Those responsible for managing the Quality System should receive training covering:

a. An introduction to the concept of the Quality System.

b. Quality management.
c. Concept of Quality Assurance.

d. Quality manuals.

e. Audit techniques.

f. Reporting and recording; and

g. The way in which the Quality System will function in the organisation.

6.1.3 Time should be provided to train every individual involved in quality management and for briefing the remainder of the employees. The allocation of time and resources should be sufficient for the scope of the training.

6.2 Sources of Training

6.2.1 Quality management courses are available from the various national or international standards institutions, and an STD operator should consider whether to offer such courses to those likely to be involved in the management of Quality Systems. STD operators with sufficient appropriately qualified staff should consider whether to carry out in-house training.

7. Standard Measurements for Flight Simulator Quality

7.1 General

7.1.1 It is recognised that a Quality System tied to measurement of STD performance will probably lead to improving and maintaining training quality. One acceptable means of measuring STD performance is as defined and agreed by industry in ARINC report 433 (May 15th, 2001 or as amended) entitled "Standard Measurements for Flight Simulator Quality".

AC No. 1 to YCAR-STD 1A.030 (acceptable means of compliance)
Flight Simulators qualified on or after 1 April 1998
See YCAR–STD 1A.030

1 Introduction

1.1 Purpose. This AC establishes the criteria which define the performance and documentation requirements for the evaluation of aeroplane flight simulators used for training, testing and checking of flight crew-members. These test criteria and methods of compliance were derived from extensive experience of Authorities and industry.

1.2 Background

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

1.2.2 The methods, procedures, and testing criteria contained in this AC are the result of the experience and expertise of Authorities, operators, and aeroplane and flight simulator manufacturers. From 1989 to 1992 a specially convened international working group under the sponsorship of the Royal Aeronautical Society (RAeS) held several meetings with the stated purpose of establishing common test criteria that would be recognised internationally. The final RAeS document, entitled International Standards for the Qualification of Airplane Flight Simulators, dated January 1992 (ISBN 0–903409–98–4), was the core document used to establish these criteria and also the ICAO Manual of Criteria for the Qualification of Flight Simulators (1995 or as amended). An international review under the co-chair of FAA and JAA during 2001 was the basis for a major modification of the ICAO Manual of Criteria for the Qualification of Flight Simulators (1995 or as amended) and for Amendment 3 of YCAR-STD 1A.

1.2.3 In showing compliance with YCAR–STD 1A.030, the Authority expects account to be taken of the IATA document entitled ‘Design and Performance Data Requirements for Flight Simulators’ – (1996 or as amended), as appropriate to the Qualification Level sought. In any case early contact with the Authority is advised at the initial stage of flight simulator build to verify the acceptability of the data.

1.3 Levels of flight simulator qualification. Parts 2, and 3 of this AC describe the minimum requirements for qualifying Level A, B, C and D aeroplane flight simulators. See also Appendix 1 to YCAR-STD 1A.030.

1.4 Terminology. Terminology and abbreviations of terms used in this AC are contained in AC STD 1A.005.

1.5 Testing for flight simulator qualification

1.5.1 The flight simulator should be assessed in those areas which are essential to completing the flight crew-member training, testing and checking process. This includes the flight simulator's longitudinal and lateral-directional responses; performance in take-off, climb, cruise, descent, approach, landing; specific operations; control checks; flight deck, flight engineer, and instructor station functions checks; and certain additional requirements depending on the complexity or Qualification Level of the flight simulator. The motion system and visual system will be evaluated to ensure their proper operation.

1.5.2 The intent is to evaluate the flight simulator as objectively as possible. Pilot acceptance, however, is also an important consideration. Therefore, the flight simulator will be subjected to validation, and functions and subjective tests listed in Part 2 and 3 of this AC. Validation tests are used to compare objectively flight simulator and aeroplane data to ensure that they agree within specified tolerances. Functions and subjective tests provide a basis for evaluating flight simulator capability to perform over a typical training period and to verify correct operation of the flight simulator.

1.5.3 Tolerances listed for parameters in the validation tests (Part 3) of this AMC are the maximum acceptable for flight simulator qualification and should not be confused with flight simulator design tolerances.

1.5.4 For initial qualification of flight simulators the aeroplane manufacturer's validation flight test data is preferred. Data from other sources may be used, subject to the review and concurrence of the Authority.
1.5.5 In the case of new aeroplane programmes, the aeroplane manufacturer's data partially validated by flight test data, may be used in the interim qualification of the flight simulator. However, the flight simulator should be re-evaluated following the release of the manufacturer's data resulting from final airworthiness approval of the aeroplane. The schedule should be as agreed by the Authority, STD operator, flight simulator manufacturer, and aeroplane manufacturer.

1.5.6 STD operators seeking initial or upgrade evaluation of a flight simulator should be aware that performance and handling data for older aeroplanes may not be of sufficient quality to meet some of the test standards contained in this AC. In this instance it may be necessary for an operator to acquire additional flight test data.

1.5.7 During flight simulator evaluation, if a problem is encountered with a particular validation test, the test may be repeated to ascertain if the problem was caused by test equipment or STD operator error. Following this, if the test problem persists, an STD operator should be prepared to offer alternative test results which relate to the test in question.

1.5.8 Validation tests which do not meet the test criteria should be addressed to the satisfaction of the Authority.

1.6 Qualification Test Guide (QTG)

1.6.1 The QTG is the primary reference document used for evaluating a flight simulator. It contains test results, statements of compliance and other information for the evaluator to assess if the flight simulator meets the test criteria described in this AC.

1.6.2 The STD operator should submit a QTG which includes:

a. A title page with STD operator and approving Authority signature blocks.

b. A flight simulator information page (for each configuration in the case of convertible flight simulators) providing:

i. STD operator's flight simulator identification number.

ii. Aeroplane model and series being simulated.

iii. Aerodynamic data revision.

iv. Engine model and its data revision.

v. Flight control data revision.

vi. Avionic equipment system identification where the revision level affects the training and checking capability of the flight simulator.

vii. Flight simulator model and manufacturer.

viii. Date of simulator manufacture.

ix. Flight simulator computer identification.

x. Visual system type and manufacturer.

xi. Motion system type and manufacturer.

c. Table of contents.

d. Log of revisions and/or list of effective pages.

e. Listing of all reference and source data.

f. Glossary of terms and symbols used.

g. Statements of Compliance (SOC) with certain requirements. SOC's should refer to sources of information and show compliance rationale to explain how the referenced material is used, applicable mathematical equations and parameter values, and conclusions reached. Refer to Appendix 2 to YCAR-STD 1A.030 for SOC requirements.

h. Recording procedures and required equipment for the validation tests.

i. The following items for each validation test are designated in paragraph 2.3:

i. Test title. This should be short and definitive, based on the test title referred to in AC No. 1 to YCAR-STD 1A.030, paragraph 2.3;

ii. Test objective. This should be a brief summary of what the test is intended to demonstrate;

iii. Demonstration procedure. This is a brief description of how the objective is to be met;

iv. References. These are the aeroplane data source documents including both the document number and the page/condition number;

v. Initial conditions. A full and comprehensive list of the test initial conditions is required;

vi. Manual test procedures. Procedures should be sufficient to enable the test to be flown by a qualified pilot, using reference to flight deck instrumentation and without reference to other parts of the QTG or flight test data;

vii. Automatic test procedures. Level C & D QTGs should include provisions for automatically conducting the test;

viii. Evaluation criteria. Specify the main parameter(s) under scrutiny during the test;

ix. Expected result(s). The aeroplane result, including tolerances and, if necessary, a further definition of the point at which the information was extracted from the source data;

x. Test result. Dated flight simulator validation test results obtained by the STD operator from the flight simulator. Tests run on a computer which is independent of the flight simulator are not acceptable;

xi. Source data. Copy of the aeroplane source data, clearly marked with the document, page number, issuing authority, and the test number and title as specified sub-para (a) above. Computer generated displays of flight test data overplotted with flight simulator data are insufficient on their own for this requirement; and

xii Comparison of results. An acceptable means of easily comparing flight simulator test results with the validation flight test data. The preferred method is overplotting.

Note: The STD operator's flight simulator test results should be recorded on a multi-channel recorder, line printer, or other appropriate recording media acceptable to the Authority conducting the test. Flight simulator results should be labelled using terminology common to aeroplane parameters as opposed to computer software identifications. These results should be easily compared with the supporting data by employing cross plotting, overlay transparencies, or other acceptable means. Aeroplane data documents included in the QTG may be photographically reduced only if such reduction will not alter the graphic scaling or cause difficulties in scale interpretation or resolution. Incremental scales on graphical presentations should provide resolution necessary for evaluation of the parameters shown in paragraph 2. The test guide will provide the documented proof of compliance with the flight simulator validation tests in the tables in paragraph 2. For tests involving time histories, flight test data sheets, or transparencies thereof, flight simulator test results should be clearly marked with appropriate reference points to ensure an accurate comparison between the flight simulator and aeroplane with respect to time. STD operators using line printers to record time histories should clearly mark that information taken from line printer data output for cross plotting on the aeroplane data. The cross plotting of the STD operator's simulator data to aeroplane data is essential to verify flight simulator performance in each test. The evaluation serves to validate the STD operator's flight simulator test results.

j. A copy of the version of the primary reference document as agreed with the Authority and used in the initial evaluation should be included.

1.7 Configuration control. A configuration control system should be established and maintained to ensure the continued integrity of the hardware and software as originally qualified.

1.8 Procedures for initial flight simulator qualification

1.8.1 The request for evaluation should reference the QTG and also include a statement that the STD operator has thoroughly tested the flight simulator and that it meets the criteria described in this document except as noted in the application form. The STD operator should further certify that all the QTG checks, for the requested Qualification Level, have been achieved and that the flight simulator is representative of the respective aeroplane.

1.8.2 A copy of the STD operator's QTG, marked with test results, should accompany the request. Any QTG deficiencies raised by the Authority should be addressed prior to the start of the on-site evaluation.

1.8.3 The STD operator may elect to accomplish the QTG validation tests while the flight simulator is at the manufacturer's facility. Tests at the manufacturer's facility should be accomplished at the latest practical time prior to disassembly and shipment. The STD operator should then validate flight simulator performance at the final location by repeating at least one-third of the validation tests in the QTG and submitting those tests to the Authority. After review of these tests, the Authority will schedule an initial evaluation. The QTG should be clearly annotated to indicate when and where each test was accomplished.

1.9 Flight simulator recurrent qualification basis

1.9.1 Following satisfactory completion of the initial evaluation and qualification tests, a periodic check system should be established to ensure that flight simulators continue to maintain their initially qualified performance, functions and other characteristics.

1.9.2 The STD operator should run the complete QTG – which includes validation, functions & subjective tests – between each annual evaluation by the Authority. The QTG should be run progressively, dated and retained in order to satisfy both the STD operator as well as the Authority that the flight simulator standards are being maintained.

Note: It is not intended that the complete QTG is run just prior to the annual evaluation.

2 Simulator Validation Tests

2.1 General

2.1.1 Flight simulator performance and system operation should be objectively evaluated by comparing the results of tests conducted in the flight simulator with aeroplane data unless specifically noted otherwise. To facilitate the validation of the flight simulator, an appropriate recording device acceptable to the Authority should be used to record each validation test result. These recordings should then be compared to the aeroplane source data.

2.1.2 Certain visual and motion tests in this paragraph, Flight Simulator Validation Tests are not necessarily based upon validation data with specific tolerances. However, these tests are included here for completeness, and the required criteria should be fulfilled instead of meeting a specific tolerance.

2.1.3 The flight simulator MQTG describe clearly and distinctly how the flight simulator will be set up and operated for each test. Use of a driver programme designed to accomplish the tests automatically is required for Level C and D flight simulators, and is encouraged for all flight simulators. 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. A manual test procedure with explicit and detailed steps for completion of each test should also be provided.

2.1.4 Submittals for approval of data other than flight test should include an explanation of validity with respect to available flight test information. Tests and tolerances in this paragraph should be included in the flight simulator MQTG. For aeroplanes certificated after January 2002 the MQTG should be supported by a

Validation Data Roadmap (VDR) as described in Appendix 2 to AC No. 1 to YCAR-STD 1A.030. Data providers are encouraged to supply a VDR for older aeroplanes.

For aeroplanes certified prior to January 1992, an operator may, after reasonable attempts have failed to obtain suitable flight test data, indicate in the MQTG where flight test data are unavailable or unsuitable for a specific test. For such a test, alternative data should be submitted to the Authority for approval.

2.1.5 The table of Flight Simulator Validation Tests in this paragraph indicates the required tests . Unless noted otherwise, flight simulator tests should represent aeroplane performance and handling qualities at operating weights and centres of gravity (cg) positions typical of normal operation. If a test is supported by aeroplane data at one extreme weight or cg, another test supported by aeroplane data at mid-conditions or as close as possible to the other extreme should be included. Certain tests which are relevant only at one extreme weight or cg condition need not be repeated at the other extreme. Tests of handling qualities should include validation of augmentation devices.

2.1.6 For the testing of Computer Controlled Aeroplane (CCA) flight simulators, flight test data are required for both the normal (N) and non-normal (NN) control states, as applicable to the aeroplane simulated and, as indicated in the validation requirements of this paragraph. Tests in the non-normal state should always include the least augmented state. Tests for other levels of control state degradation may be required as detailed by the Authority at the time of definition of a set of specific aeroplane tests for flight simulator data. Where applicable, flight test data should record:

a. pilot controller deflections or electronically generated inputs including location of input; and

b. flight control surface positions unless test results are not affected by, or are independent of, surface positions.

2.1.7 The recording requirements of 2.1.6 a) and b) 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.

2.1.8 Where non-normal control states are required, test data should be provided for one or more non-normal control states including the least augmented state.

2.1.9 Where normal, non-normal or other degraded control states are not applicable to the aeroplane being simulated, appropriate rationales should be included in the aeroplane manufacturer's validation data roadmap (VDR), which is described in Appendix 2 to AC No. 1 to YCAR-STD 1A.030.

2.2 Test requirements

2.2.1 The ground and flight tests required for qualification are listed in the table of Flight Simulator Validation Tests. Computer generated flight simulator test results should be provided for each test. The results should be produced on an appropriate recording device acceptable to the Authority. Time histories are required unless otherwise indicated in the table of validation tests.

2.2.2 Flight test data which exhibit rapid variations of the measured parameters may require engineering judgement when making assessments of flight simulator validity. Such judgement should not be limited to a single parameter. All relevant parameters related to a given manoeuvre or flight condition should be provided to allow overall interpretation. When it is difficult or impossible to match flight simulator to aeroplane data throughout a time history, differences should be justified by providing a comparison of other related variables for the condition being assessed.

2.2.2.2 Flight condition verification. When comparing the parameters listed to those of the aeroplane, sufficient data should also be provided to verify the correct flight condition. For example, to show the control force is within ± 2·2 daN (5 pounds) 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 given. If comparing short period dynamics, 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 given. All airspeed values should be assumed to be calibrated unless annotated otherwise and like values used for comparison.

2.2.2.3 For Level 'A' flight simulator, where the tolerances have been replaced by 'Correct Trend and Magnitude' (CT&M), the flight simulator should be tested and assessed as representative of the aeroplane to the satisfaction of the Authority. To facilitate future evaluations, sufficient parameters should be recorded to establish a reference.

2.2.2.4 Flight conditions. The flight conditions are specified as follows:

a. Ground-on ground, independent of aeroplane configuration

b. Take-off - gear down with flaps in any certified takeoff position

c. Second segment climb – gear up with flaps in any certified takeoff position

d. Clean – flaps and gear up

e. Cruise – clean configuration at cruise altitude and airspeed

f. Approach – gear up or down with flaps at any normal approach positions as recommended by the aeroplane manufacturer

g. Landing – gear down with flaps in any certified landing position.

2.3 Table of Flight Simulator Validation Tests

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
			'CT&M' in the Level A column means 'Correct Trend and Magnitude'				
1. PERFORMANCE a. TAXY (1) Minimum Radius Turn.	± 0·9 m (3 ft) or ± 20% of aeroplane turn radius.	Ground	Plot both main and nose gear-turning loci. Data for no brakes and the minimum thrust required to maintain a steady turn except for aeroplanes requiring asymmetric thrust or braking to turn.	CT&M	✓	✓	✓
(2) Rate of Turn vs. Nosewheel Steering Angle (NWA).	± 10% or ± 2º/s turn rate.	Ground	Tests for a minimum of two speeds, greater than minimum turning radius speed, with a spread of at least 5 kts groundspeed.	CT&M	✓	✓	✓
b. TAKE-OFF			Note-All commonly used take-off flap settings should be demonstrated at least once either in minimum unstick speed (1b3), normal take-off (1b4), critical engine failure on take-off (1b5) or cross wind take-off (1b6).				
(1) Ground Acceleration Time and Distance.	± 5% time and distance or ± 5% time and ± 61 m (200 ft) of distance	Take-off	Acceleration time and distance should be recorded for a minimum of 80% of the total time from brake release to V_R. May be combined with normal takeoff (1b4) or rejected takeoff (1b7). Plotted data should be shown using appropriate scales for each portion of the manoeuvre.	CT&M	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
(2) Minimum Control Speed, ground (V_{MCG}) aerodynamic controls only per applicable airworthiness requirement or alternative engine inoperative test to demonstrate ground control characteristics.	± 25% of maximum aeroplane lateral deviation or ± 1·5 m (5 ft) For aeroplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) rudder pedal force	Take-off	Engine failure speed should be within ± 1 kt of aeroplane engine failure speed. Engine thrust decay should be that resulting from the mathematical model for the engine variant applicable to the flight simulator under test. If the modelled engine variant is not the same as the aeroplane manufacturers' flight test engine, then a further test may be run with the same initial conditions using the thrust from the flight test data as the driving parameter. If a V_{MCG} test is not available an acceptable alternative is a flight test snap engine deceleration to idle at a speed between V1 and V1-10 kts, followed by control of heading using aerodynamic control only and recovery should be achieved with the main gear on the ground. To ensure only aerodynamic control, nosewheel steering should be disabled (i.e., castored) or the nosewheel held slightly off the ground.	C T & M	✓	✓	✓
(3) Minimum Unstick Speed (V_{MU}) or equivalent test to demonstrate early rotation take off characteristics.	± 3 kts airspeed ± 1·5º pitch angle	Take-off	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 should be recorded. 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. Record time history data from 10 kts before start of rotation until at least 5 seconds after the occurrence of main gear lift-off.	C T & M	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(4) Normal Take-off.	± 3 kts airspeed ± 1·5º pitch angle ± 1·5º AOA ± 6 m (20 ft) height For aeroplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force	Take-off	Data required for near maximum certificated take-off weight at mid centre of gravity and light take-off weight at an aft centre of gravity. If the aeroplane has more than one certificated take-off configuration, a different configuration should be used for each weight. Record take-off profile from brake release to at least 61 m (200 ft) AGL. May be used for ground acceleration time and distance (1b1). Plotted data should be shown using appropriate scales for each portion of the manoeuvre.	C T & M	✓	✓	✓
(5) Critical Engine Failure on Take-off.	± 3 kts airspeed ± 1·5º pitch angle ± 1·5º AOA ± 6 m (20 ft) height ± 2º bank and sideslip angle ± 3° heading angle For aeroplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force ± 10or ± 1·3 daN (3 lb) wheel force ± 10% or ± 2·2 daN (5 lb) rudder pedal force.	Take-off	Record take-off profile to at least 61 m (200 ft) AGL. Engine failure speed should be within ± 3 kts of aeroplane data. Test at near maximum take-off weight.	C T & M	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
(6) Crosswind Take-off.	± 3 kts airspeed ± 1·5º pitch angle ± 1·5º AOA ± 6 m (20 ft) height ± 2º bank and sideslip angle ± 3° heading Correct trends at airspeeds below 40 kts for rudder/pedal and heading. For aeroplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force ± 10% or ± 1·3 daN (3 lb) wheel force ± 10% or ± 2·2 daN (5 lb) rudder pedal force	Take-off	Record take-off profile from brake release to at least 61 m (200 ft) AGL. Requires test data, including wind profile, for a crosswind component of at least 60% of the AFM value measured at 10m (33 ft) above the runway.	C T & M	✓	✓	✓
(7) Rejected Take-off.	± 5% time or ± 1·5 s ± 7·5% distance or ± 76 m (250 ft)	Take-off	Record near maximum take-off weight. Speed for reject should be at least 80% of V_1. Autobrakes will be used where applicable. Maximum braking effort, auto or manual. Time and distance should be recorded from brake release to a full stop.	C T & M	✓	✓	✓
(8) Dynamic Engine Failure after Take-off.	± 20% or ± 2º/s body angular rates	Take-off	Engine failure speed should be within ± 3 kts of aeroplane data. Engine failure may be a snap deceleration to idle. Record hands off from 5 secs before engine failure to + 5 secs or 30 deg bank, whichever occurs first. 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. CCA: Test in normal AND Non-normal Control state.	C T & M	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
c. CLIMB (1) Normal Climb All Engines Operating	± 3 kts airspeed ± 5% or ± 0·5 m/s (100 ft/min) R/C	Clean	Flight test data or aeroplane performance manual data may be used. Record at nominal climb speed and mid initial climb altitude. Flight simulator performance to be recorded over an interval of at least 300 m (1 000 ft).	✓	✓	✓	✓
(2) One Engine Inoperative Second Segment Climb.	± 3 kts airspeed ± 5% or ± 0·5 m/s (100 ft/min) R/C but not less than AFM values.	2nd Segment Climb	Flight test data or aeroplane performance manual data may be used. Record at nominal climb speed. Flight simulator performance to be recorded over an interval of at least 300m (1 000 ft). Test at WAT (Weight, Altitude, or Temperature) limiting condition.		✓	✓	✓
(3) One Engine Inoperative En route Climb.	± 10% time ± 10% distance ± 10% fuel used	Clean	Flight test data or aeroplane performance manual data may be used. Test for at least a 1 550 m (5 000 ft) segment.	✓	✓	✓	✓
(4) One Engine Inoperative Approach Climb for aeroplanes with icing accountability if required by the flight manual for this phase of flight.	± 3 kts airspeed ± 5% or ± 0·5 m/s (100 ft/min) R/C but not less than AFM values	Approach	Flight test data or aeroplane performance manual data may be used. Flight simulator performance to be recorded over an interval of at least 300 m (1 000 ft). Test near maximum certificated landing weight as may be applicable to an approach in icing conditions. Aeroplane should be configured with all anti-ice and de-ice systems operating normally, gear up and go-around flap. All icing accountability considerations, in accordance with the flight manual for an approach in icing conditions, should be applied.			✓	✓
d. CRUISE / DESCENT							

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(1) Level Flight Acceleration	± 5% time	Cruise	Minimum of 50 kts increase using maximum continuous thrust rating or equivalent.	CT & M	✓	✓	✓
(2) Level Flight Deceleration	± 5% time	Cruise	Minimum of 50 kts decrease using idle power.	CT & M	✓	✓	✓
. (3) Cruise Performance	± 0·05 EPR or ± 5% N1 or ± 5% torque ± 5% fuel flow	Cruise	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.	✓	✓	✓	✓
(4) Idle Descent	± 3 kts airspeed ± 5% or ± 1·0 m/s (200 ft/min) R/D	Clean	Idle power stabilised descent at normal descent speed at mid altitude. Flight simulator performance to be recorded over an interval of at least 300 m (1 000 ft).	✓	✓	✓	✓
(5) Emergency Descent	± 5 kts airspeed ± 5% or ± 1·5 m/s (300 ft/min) R/D	As per AFM	Stabilised descent to be conducted with speedbrakes extended if applicable, at mid altitude and near VMO or according to emergency descent procedure. Flight simulator performance to be recorded over an interval of at least 900 m (3 000 ft).	✓	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
e. STOPPING (1) Deceleration Time and Distance, Manual Wheel Brakes, Dry Runway, No Reverse Thrust.	± 5% of time. For distances up to 1 220 m (4 000 ft) ± 61 m (200 ft) or ± 10%, whichever is the smaller. For distances greater than 1 220 m (4 000 ft) ± 5% distance.	Landing	Time and Distance should be recorded for at least 80% of the total time from touchdown to a full stop. Data required for medium and near maximum certificated landing weight. Engineering data may be used for the medium weight condition. Brake system pressure should be recorded.	CT&M	✓	✓	✓
(2) Deceleration Time and Distance, Reverse Thrust, No Wheel Brakes, Dry Runway.	± 5% time and the smaller of ± 10% or ± 61 m (200 ft) of distance.	Landing	Time and distance should be recorded for at least 80% of the total time from initiation of reverse thrust to full thrust reverser minimum operating speed. Data required for medium and near maximum certificated landing weights. Engineering data may be used for the medium weight condition.	CT&M	✓	✓	✓
(3) Stopping Distance, Wheel Brakes, Wet Runway.	± 10% or ± 61 m (200 ft) distance	Landing	Either flight test or manufacturers performance manual data should be used where available. Engineering data, based on dry runway flight test stopping distance and the effects of contaminated runway braking coefficients, are an acceptable alternative.			✓	✓
(4) Stopping Distance, Wheel Brakes, Icy Runway.	± 10% or ± 61 m (200 ft) distance	Landing	Either flight test or manufacturer's performance manual data should be used where available. Engineering data, based on dry runway flight test stopping distance and the effects of contaminated runway braking coefficients, are an acceptable alternative.			✓	✓

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
f. ENGINES (1) Acceleration.	± 10% T_i or ± 0·25s ± 10% T_t	Approach or Landing	T_i = Total time from initial throttle movement until a 10% response of a critical engine parameter. T_t = Total time from initial throttle movement to 90% of go around power. Critical engine parameter should be a measure of power (N1, N2, EPR, etc). Plot from flight idle to go around power for a rapid throttle movement.	C T & M	✓	✓	✓
(2) Deceleration.	± 10% T_i or ± 0·25s ± 10% T_t	Ground	T_i = Total time from initial throttle movement until a 10% response of a critical engine parameter. T_t = Total time from initial throttle movement to 90% decay of maximum take-off power. Plot from maximum take-off power to idle for a rapid throttle movement.	C T & M	✓	✓	✓
2. HANDLING QUALITIES a STATIC CONTROL CHECKS			NOTE: Pitch, roll and yaw controller position vs. force or time shall be measured at the control. An alternative method would be to instrument the flight simulator in an equivalent manner to the flight test aeroplane. The force and position data from this instrumentation can be directly recorded and matched to the aeroplane data. Such a permanent installation could be used without any time for installation of external devices. Testing of position versus force is not applicable if forces are generated solely by use of aeroplane hardware in the flight simulator.				

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(1) Pitch Controller Position vs. Force and Surface Position Calibration.	± 0·9 daN (2 lbs) breakout. ± 2·2 daN (5 lbs) or ± 10% force. ± 2º elevator angle	Ground	Uninterrupted control sweep to stops. Should be validated (where possible) with inflight data from tests such as longitudinal static stability, stalls, etc. Static and dynamic flight control tests should be accomplished at the same feel or impact pressures.	✓	✓	✓	✓
(2) Roll Controller Position vs. Force and Surface Position Calibration.	± 0·9 daN (2 lbs) breakout ± 1·3 daN (3 lbs) or ± 10% force ± 2º aileron angle ± 3º spoiler angle	Ground	Uninterrupted control sweep to stops. Should be validated with in-flight data from tests such as engine out trims, steady state sideslips, etc. Static and dynamic flight control tests should be accomplished at the same feel or impact pressures.	✓	✓	✓	✓
(3) Rudder Pedal Position vs. Force and Surface Position Calibration.	± 2·2 daN (5 lbs) breakout ± 2·2 daN (5 lbs) or ± 10% force ± 2º rudder angle	Ground	Uninterrupted control sweep to stops. Should be validated with in flight data from tests such as engine out trims, steady state sideslips, etc. Static and dynamic flight control tests should be accomplished at the same feel or impact pressures.	✓	✓	✓	✓
(4) Nosewheel Steering Controller Force and Position Calibration.	± 0·9 daN (2 lbs) breakout ± 1·3 daN (3 lbs) or ± 10% force ± 2º NWA	Ground	Uninterrupted control sweep to stops.	C T & M	✓	✓	✓
(5) Rudder Pedal Steering Calibration.	± 2º NWA	Ground	Uninterrupted control sweep to stops.	C T & M	✓	✓	✓
(6) Pitch Trim Indicator vs. Surface Position Calibration	± 0·5º trim angle.	Ground	Purpose of test is to compare flight simulator against design data or equivalent.	✓	✓	✓	✓
(7) Pitch Trim Rate	± 10% trim rate (°/s)	Ground and approach	Trim rate to be checked at pilot primary induced trim rate (ground) and autopilot or pilot primary trim rate in flight at go-around flight conditions.	✓	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
(8) Alignment of Cockpit Throttle Lever vs. Selected Engine Parameter.	± 5º of TLA or ± 3% N1 or ± 0·03 EPR or ± 3% torque For propeller-driven aeroplanes, where the propeller levers do not have angular travel, a tolerance of ± 2 cm (± 0·8 in) applies.	Ground	Simultaneous recording for all engines. The tolerances apply against aeroplane data and between engines. For aeroplanes with throttle detents, all detents to be presented. In the case of propeller-driven aeroplanes, if an additional lever, usually referred to as the propeller lever, is present, it should also be checked. May be a series of Snapshot tests.	✓	✓	✓	✓
(9) Brake Pedal Position vs. Force and Brake System Pressure Calibration.	± 2·2 daN (5 lbs) or ± 10% force. ± 1·0 MPa (150 psi) or ± 10% brake system pressure.	Ground	Flight simulator computer output results may be used to show compliance. Relate the hydraulic system pressure to pedal position in a ground static test.	CT&M	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
b. DYNAMIC CONTROL CHECKS			Tests 2b1, 2b2, and 2b3 are not applicable if dynamic response is generated solely by use of aeroplane hardware in the flight simulator. Power setting may be that required for level flight unless otherwise specified.				
(1) Pitch Control.	For underdamped systems: ± 10% of time from 90% of initial displacement (A_d) to first zero crossing and ± 10(n+1)% of period thereafter. ± 10% amplitude of first overshoot applied to all overshoots greater than 5% of initial displacement (A_d). ± 1 overshoot (first significant overshoot should be matched) For overdamped systems: ± 10% of time from 90% of initial displacement (Ad) to 10 % of initial displacement (0·1 Ad).	Take-off, Cruise, and Landing	Data should be for normal control displacements in both directions (approximately 25% to 50% full throw or approximately 25% to 50% of maximum allowable pitch controller deflection for flight conditions limited by the manoeuvring load envelope). Tolerances apply against the absolute values of each period (considered independently). n = The sequential period of a full oscillation. Refer to paragraph 2.4.1			✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(2) Roll Control.	For underdamped systems: ± 10% of time from 90% of initial displacement (A_d) to first zero crossing and ± 10(n+1)% of period thereafter. ± 10% amplitude of first overshoot applied to all overshoots greater than 5% of initial displacement (A_d). ± 1 overshoot (first significant overshoot should be matched) For overdamped systems: ± 10% of time from 90% of initial displacement (Ad) to 10 % of initial displacement (0·1 Ad).	Take-off, Cruise, and Landing	Data should be for normal control displacement (approximately 25% to 50% of full throw or approximately 25% to 50% of maximum allowable roll controller deflection for flight conditions limited by the manoeuvring load envelope). Refer to paragraph 2.4.1			✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(3) Yaw Control.	For underdamped systems: ± 10% of time from 90% of initial displacement (A_d) to first zero crossing and ± 10(n+1)% of period thereafter. ± 10% amplitude of first overshoot applied to all overshoots greater than 5% of initial displacement (A_d). ± 1 overshoot (first significant overshoot should be matched) For overdamped systems: ± 10% of time from 90% of initial displacement (Ad) to 10 % of initial displacement (0·1 Ad).	Take-off, Cruise and Landing	Data should be for normal displacement (Approximately 25% to 50% of full throw). Refer to paragraph 2.4.1			✓	✓
(4) Small Control Inputs - pitch.	± 0·15 °/s body pitch rate or ± 20% of peak body pitch rate applied throughout the time history.	Approach or Landing	Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0·5 to 2 °/s pitch rate). Test in both directions. Show time history data from 5 seconds before until at least 5 seconds after initiation of control input. CCA: Test in normal AND non-normal control state.			✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(5) Small Control Inputs - roll	± 0·15 °/s body roll rate or ± 20% of peak body roll rate applied throughout the time history	Approach or landing	Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0·5 to 2 °/s roll rate). Test in one direction. For aeroplanes that exhibit non-symmetrical behaviour, test in both directions. Show time history data from 5 seconds before until at least 5 seconds after initiation of control input. CCA: Test in normal AND non-normal control state.			✓	✓
(6) Small Control Inputs – yaw	± 0·15 °/s body yaw rate or ± 20 of peak body yaw rate applied throughout the time history	Approach or landing	Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0·5 to 2 °/s yaw rate). Test in one direction. For aeroplanes that exhibit non-symmetrical behaviour, test in both directions. Show time history data from 5 seconds before until at least 5 seconds after initiation of control input. CCA: Test in normal AND non-normal control state.			✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
c. LONGITUDINAL			Power setting may be that required for level flight unless otherwise specified.				
(1) Power Change Dynamics.	± 3 kts airspeed ± 30 m (100 ft) altitude. ± 1·5º or ± 20% pitch angle	Approach	Power change from thrust for approach or level flight to maximum continuous or go-around power. Time history of uncontrolled free response for a time increment equal to at least 5 secs before initiation of the power change to completion of the power change + 15 secs. CCA: Test in Normal AND Non-normal Control state.		✓	✓	✓
(2) Flap Change Dynamics.	± 3 kts airspeed ± 30 m (100 ft) altitude. ± 1·5º or ± 20% pitch angle	Take-off through initial flap retraction and approach to landing	Time history of uncontrolled free response for a time increment equal to at least 5 secs before initiation of the reconfiguration change to completion of the reconfiguration change + 15 secs. CCA: Test in Normal AND Non-normal Control state.	✓	✓	✓	✓
(3) Spoiler/Speedbrake Change Dynamics.	± 3 kts airspeed ± 30 m (100 ft) altitude. ± 1·5 º or ± 20% pitch angle	Cruise	Time history of uncontrolled free response for a time increment equal to at least 5 secs before initiation of the reconfiguration change to completion of the reconfiguration change + 15 secs. Results required for both extension and retraction. CCA: Test in Normal AND Non-normal Control state.	✓	✓	✓	✓
(4) Gear Change Dynamics.	± 3 kts airspeed ± 30 m (100 ft) altitude. ± 1·5º or ± 20% pitch angle	Takeoff (retraction) and Approach (extension)	Time history of uncontrolled free response for a time increment equal to at least 5 secs before initiation of the configuration change to completion of the reconfiguration change + 15 secs. CCA: Test in Normal AND Non-normal Control state.	✓	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
(5) Longitudinal Trim.	± 1º elevator ± 0·5º stabilizer ± 1º pitch angle ± 5% net thrust or equivalent	Cruise, Approach and Landing	Steady-state wings level trim with thrust for level flight. May be a series of snapshot tests. CCA: Test in Normal OR Non-normal Control state.	✓	✓	✓	✓
(6) Longitudinal Manoeuvring Stability (Stick Force/g).	± 2·2 daN (5 lbs) or ± 10% pitch controller force Alternative method: ± 1º or ± 10% change of elevator	Cruise, Approach and Landing	Continuous time history data or a series of snapshot tests may be used. Test up to approximately 30º of bank for approach and landing configurations. Test up to approximately 45º of bank for the cruise configuration. Force tolerance not applicable if forces are generated solely by the use of aeroplane hardware in the flight simulator. Alternative method applies to aeroplanes which do not exhibit stick-force-per-g characteristics. CCA: Test in Normal AND Non-normal Control state as applicable.	✓	✓	✓	✓
(7) Longitudinal Static Stability.	± 2·2 daN (5 lbs) or ± 10% pitch controller force. Alternative method: ± 1° or ± 10% change of elevator	Approach	Data for at least two speeds above and two speeds below trim speed. May be a series of snapshot tests. Force tolerance not applicable if forces are generated solely by the use of aeroplane hardware in the flight simulator. Alternative method applies to aeroplanes which do not exhibit speed stability characteristics. CCA: Test in Normal OR Non-normal Control state as applicable.	✓	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(8) Stall Characteristics.	± 3 kts airspeed for initial buffet, stall warning, and stall speeds. For aeroplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force (prior to g-break only.)	2nd Segment Climb and Approach or Landing	Wings-level (1 g) stall entry with thrust at or near idle power. Time history data should be shown to include full stall and initiation of recovery. Stall warning signal should be recorded and should occur in the proper relation to stall. Flight simulators for aeroplanes exhibiting a sudden pitch attitude change or 'g break' should demonstrate this characteristic. CCA: Test in Normal AND Non-normal Control state.	✓	✓	✓	✓
(9) Phugoid Dynamics.	± 10% period. ± 10% time to ½ or double amplitude or ± 0·02 of damping ratio.	Cruise	Test should include 3 full cycles or that necessary to determine time to ½ or double amplitude, whichever is less. CCA: Test in Non-normal Control state.	✓	✓	✓	✓
(10) Short Period Dynamics.	± 1·5º pitch angle or ± 2º/s pitch rate. ± 0·1 g normal acceleration.	Cruise	CCA: Test in Normal AND Non-normal Control state.	✓	✓	✓	✓
d. LATERAL DIRECTIONAL			Power setting may be that required for level flight unless otherwise specified.				
(1) Minimum Control Speed, Air (V_{MCA} or V_{MCL}), per Applicable Airworthiness Standard – or – Low Speed Engine Inoperative Handling Characteristics in the Air.	± 3 kts airspeed	Take-off or Landing (whichever is most critical in the aeroplane)	Minimum speed may be defined by a performance or control limit which prevents demonstration of V_{MC} or V_{MCL} in the conventional manner. Take-off thrust should be set on the operating engine(s). Time history or snapshot data may be used CCA: Test in Normal OR Non-normal Control state.	C T & M	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(2) Roll Response (Rate).	± 10% or ± 2º/sec roll rate For aeroplanes with reversible flight control systems: ± 10% or ± 1·3 daN (3 lb) roll controller force.	Cruise and Approach or Landing	Test with normal roll control displacement (about 30% of maximum control wheel). May be combined with step input of flight deck roll controller test (2d3).	✓	✓	✓	✓
(3) Step Input of Cockpit Roll Controller.	± 10% or ± 2º bank angle	Approach or Landing	With wings level, apply a step roll control input using approximately one-third of roll controller travel. At approximately 20° to 30° bank, abruptly return the roll controller to neutral and allow at least 10 seconds of aeroplane free response. May be combined with roll response (rate) test (2d2). CCA: Test in Normal AND Non-normal Control state.	✓	✓	✓	✓
(4) Spiral Stability.	Correct trend and ± 2º or ± 10% bank angle in 20 seconds If alternate test is used: correct trend and ± 2° aileron.	Cruise and approach or landing	Aeroplane data averaged from multiple tests may be used. Test for both directions. As an alternative test, show lateral control required to maintain a steady turn with a bank angle of approximately 30°. CCA: Test in Non-normal Control state.	✓	✓	✓	✓
(5) Engine Inoperative Trim.	± 1º rudder angle or ± 1º tab angle or equivalent pedal. ± 2º sideslip angle.	2nd Segment Climb and Approach or Landing	Test should be performed in a manner similar to that for which a pilot is trained to trim an engine failure condition. 2nd segment climb test should be at take-off thrust. Approach or landing test should be at thrust for level flight. May be snapshot tests.	✓	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(6) Rudder Response.	± 2º/s or ± 10% yaw rate	Approach or Landing	Test with stability augmentation ON and OFF. Test with a step input at approximately 25% of full rudder pedal throw. CCA: Test in Normal AND Non-normal Control state.	✓	✓	✓	✓
(7) Dutch Roll (Yaw Damper OFF).	± 0·5 s or ± 10% of period. ± 10% of time to ½ or double amplitude or ± 0·02 of damping ratio. ± 20% or ± 1 s of time difference between peaks of bank and sideslip	Cruise and Approach or Landing	Test for at least 6 cycles with stability augmentation OFF. CCA: Test in Non-normal Control state.	✓	✓	✓	✓
(8) Steady State Sideslip.	For a given rudder position: ± 2º bank angle ± 1º sideslip angle ± 10% or ± 2º aileron ± 10% or ± 5º spoiler or equivalent roll controller position or force For aeroplanes with reversible flight control systems: ±10% or ±1·3 daN (3 lb) wheel force ±10% or ±2·2 daN (5 lb) rudder pedal force.	Approach or Landing	May be a series of snapshot tests using at least two rudder positions (in each direction for propeller driven aeroplanes) one of which should be near maximum allowable rudder.	✓	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
e. LANDINGS (1) Normal Landing.	± 3 kts airspeed ± 1·5º pitch angle ± 1·5º AOA ± 3 m (10 ft) or ± 10% of height For aeroplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force	Landing	Test from a minimum of 61 m (200 ft) AGL to nosewheel touch- down. Two tests should be shown, including two normal landing flaps (if applicable) one of which should be near maximum certificated landing weight, the other at light or medium weight CCA: Test in Normal AND Non-normal Control state if applicable.	C T & M	✓	✓	✓
(2) Minimum Flap Landing.	± 3 kts airspeed ± 1·5º pitch angle ± 1·5º AOA ± 3 m (10 ft) or ± 10% of height For aeroplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force	Minimum Certified Landing Flap Configuration	Test from a minimum of 61 m (200 ft) AGL to nosewheel touchdown. Test at near maximum landing weight.		✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
(3) Crosswind Landing.	± 3 kts airspeed ± 1·5º pitch angle ± 1·5º AOA ± 3 m (10 ft) or ± 10% height ± 2º bank angle ± 2º sideslip angle ± 3° heading angle For aeroplanes with reversible flight control systems: ± 10% or ± 2·2 daN (5 lb) column force ± 10% or ± 1·3 daN (3 lb) wheel force ± 10% or ± 2·2 daN (5 lb) rudder pedal force.	Landing	Test from a minimum of 61 m (200 ft) AGL to a 50% decrease in main landing gear touchdown speed. Requires test data, including wind profile, for a crosswind component of at least 60% of AFM value measured at 10m (33 ft) above the runway.		✓	✓	✓
(4) One Engine Inoperative Landing.	± 3 kts airspeed ± 1·5º pitch angle ± 1·5º AOA ± 3 m (10 ft) or ± 10% height ± 2º bank angle ± 2º sideslip angle ± 3° heading angle	Landing	Test from a minimum of 61 m (200 ft) AGL to a 50% decrease in main landing gear touchdown speed.		✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(5) Autopilot Landing (if applicable).	± 1·5 m (5 ft) flare height. ± 0·5 s or ± 10%T_f. ± 0·7 m/s (140 ft/min) R/D at touchdown. ± 3 m (10 ft) lateral deviation during rollout.	Landing	If autopilot provides rollout guidance, record lateral deviation from touchdown to a 50% decrease in main landing gear touchdown speed. Time of autopilot flare mode engage and main gear touchdown should be noted. This test is not a substitute for the ground effects test requirement. T_f = Duration of Flare.		✓	✓	✓
(6) All engine autopilot Go Around.	± 3 kts airspeed ± 1·5° pitch angle ± 1·5° AOA	As per AFM	Normal all engine autopilot go around should be demonstrated (if applicable) at medium weight. CCA: Test in Normal AND Non-normal		✓	✓	✓
(7) One-Engine-inoperative Go-around	± 3 kts airspeed ±1·5° pitch angle ±1·5° AOA ± 2° bank angle ± 2° sideslip angle	As per AFM	Engine inoperative go-around required near maximum certificated landing weight with critical engine(s) inoperative. Provide one test with autopilot (if applicable) and one without autopilot. CCA: Non-autopilot test to be conducted in Non-normal mode.		✓	✓	✓
(8) Directional Control (Rudder Effectiveness) with Reverse Thrust symmetric).	± 5 kts airspeed ± 2°/s yaw rate	Landing	Apply rudder pedal input in both directions using full reverse thrust until reaching full thrust reverser minimum operating speed.		✓	✓	✓
(9) Directional Control (Rudder Effectiveness) with Reverser Thrust (asymmetric)	± 5 kts airspeed ± 3° heading angle	Landing	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.		✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
f. GROUND EFFECT (1) A Test to demonstrate Ground Effect.	± 1º elevator ± 0·5º stabilizer angle. ± 5% net thrust or equivalent. ± 1º AOA ± 1·5 m (5 ft) or ± 10% height ± 3 kts airspeed ± 1º pitch angle	Landing	See Paragraph 2.4.2. A rationale should be provided with justification of results. CCA: Test in Normal OR Non-normal control state.		✓	✓	✓
g. WIND SHEAR (1) Four Tests, two take-off and two landing with one of each conducted in still air and the other with Wind Shear active to demonstrate Wind Shear models.	None	Take-off and Landing	Wind shear models are required which provide training in the specific skills required for recognition of wind shear phenomena and execution of recovery manoeuvres.			✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
			Wind shear models should be representative of measured or accident derived winds, but may be simplifications which ensure repeatable encounters. For example, models may consist of independent variable winds in multiple simultaneous components. Wind models should be available for the following critical phases of flight: (1) Prior to take-off rotation (2) At lift-off (3) During initial climb (4) Short final approach The United States Federal Aviation Administration (FAA) Wind shear Training Aid, wind models from the Royal Aerospace Establishment (RAE), the United States Joint Aerodrome Weather studies (JAWS) Project or other recognised sources may be implemented and should be supported and properly referenced in the QTG. Wind models from alternate sources may also be used if supported by aeroplane related data and such data are properly supported and referenced in the QTG. Use of alternate data should be co-ordinated with the Authority prior to submittal of the QTG for approval.				
h FLIGHT AND MANOEUVRE ENVELOPE PROTECTION FUNCTIONS			This paragraph is only applicable to computer-controlled aeroplanes. 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. Set thrust as required to reach the envelope protection function.				
. (1) Overspeed	± 5 kts airspeed	Cruise		✓	✓	✓	✓
(2) Minimum Speed.	± 3 kts airspeed	Take-off, Cruise and Approach or Landing		✓	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
(3) Load Factor.	± 0·1 g	Take-off, Cruise		✓	✓	✓	✓
(4) Pitch Angle.	± 1·5º pitch angle	Cruise, Approach		✓	✓	✓	✓
(5) Bank Angle.	± 2º or ± 10% bank angle	Approach		✓	✓	✓	✓
(6) Angle of Attack.	± 1·5º AOA	Second Segment Climb and Approach or Landing		✓	✓	✓	✓
3. MOTION SYSTEM a. FREQUENCY RESPONSE	As specified by the applicant for flight simulator qualification.	Not Applicable	Appropriate test to demonstrate frequency response required. See also AC No. 1 to YCAR-STD 1A.030 para 2.4.3.2	✓	✓	✓	✓
b. LEG BALANCE	As specified by the applicant for flight simulator qualification.	Not Applicable	Appropriate test to demonstrate leg balance required. See also AC No. 1 to YCAR-STD 1A.030 para 2.4.3.2	✓	✓	✓	✓
c. TURN-AROUND CHECK	As specified by the applicant for flight simulator qualification.	Not Applicable	Appropriate test to demonstrate smooth turn around required. See also AC No. 1 to YCAR-STD 1A.030 para 2.4.3.2	✓	✓	✓	✓
d. MOTION EFFECTS			Refer to AC No 1 to YCAR-STD 1A.030 3.3(n) subjective testing.				
e. Motion System Repeatability	± 0·05g actual platform linear accelerations	None	Ensure that motion system hardware and software (in normal flight simulator operating mode) continue to perform as originally qualified. Performance changes from the original baseline can be readily identified with this information. See AC No. 1 to YCAR-STD 1A.030 para 2.4.3.4			✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
f. Motion Cueing Performance Signature	None	Ground and flight	For a given set of flight simulation critical manoeuvres record the relevant motion variables. These tests should be run with the motion buffet module disabled. See AC No. 1 to YCAR-STD 1A.030 para 2.4.3.3	✓	✓	✓	✓
g. CHARACTERISTIC MOTION VIBRATIONS	None	Ground and Flight	The recorded test results for characteristic buffets should allow the comparison of relative amplitude versus frequency. For atmospheric disturbance testing, general purpose disturbance models that approximate demonstrable flight test data are acceptable. Principally, the flight simulator results should exhibit the overall appearance and trends of the aeroplane plots, with at least some of the frequency “spikes” being present within 1 or 2 Hz of the aeroplane data. See AC No. 1 to YCAR-STD 1A.030 para 2.4.3.5				

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
The following tests with recorded results and an SOC are required for characteristic motion vibrations, which can be sensed at the flight deck where applicable by aeroplane type:							✓
(1)Thrust effects with brakes set	n/a	Ground	Test should be conducted at maximum possible thrust with brakes set				
(2) landing gear extended buffet	n/a	Flight	Test condition should be for a normal operational speed and not at the gear limiting speed.				
(3) flaps extended buffet	n/a	Flight	Test condition should be for a normal operational speed and not at the flap limiting speed.				
(4) speedbrake deployed buffet	n/a	Flight					
(5) approach-to-stall buffet	n/a	Flight	Test condition should be approach-to-stall. Post-stall characteristics are not required				
(6) high speed or Mach buffet	n/a	Flight	Test condition should be for high speed manoeuvre buffet/wind-up-turn or alternatively Mach buffet.				
(7) -flight vibrations	n/a	Flight (clean configuration)	Test should be conducted to be representative of in-flight vibrations for propeller driven aeroplanes				
4 VISUAL SYSTEM a. SYSTEM RESPONSE TIME							

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(1) Transport Delay.	150 milliseconds or less after controller movement.	Pitch, roll and yaw	One separate test is required in each axis. See Appendix 5 to AC STD 1A.030			✓	✓
	300 milliseconds or less after controller movement.			✓	✓		
– or –							
(2) Latency	– 150 milliseconds or less after aeroplane response.	Take-off, Cruise, and Approach or Landing	One test is required in each axis (pitch, roll, yaw) for each of the 3 conditions compared with aeroplane data for a similar input. The visual scene or test pattern used during the response testing shall be representative of the required system capacities to meet the daylight, twilight (dusk/dawn) and night visual capability as applicable. Response tests should be confirmed in daylight , twilight and night settings as applicable.			✓	✓
	– 300 milliseconds or less after aeroplane response. .			✓	✓		

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
b. DISPLAY SYSTEM TESTS.							
(1) (a) Continuous collimated cross-cockpit visual field of view	Continuous, cross-cockpit, minimum collimated visual field of view providing each pilot with 180 degrees horizontal and 40 degrees vertical field of view. Horizontal FOV: Not less than a total of 176 measured degrees (including not less than ±88 measured degrees either side of the centre of the design eye point). Vertical FOV: Not less than a total of 36 measured degrees from the pilot's and co-pilot's eye point.	Not Applicable	Field of view should 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 should be confirmed in a Statement of Compliance.			✓	✓
(b) Continuous collimated visual field of view	Continuous, minimum collimated visual field of view providing each pilot with 45 degrees horizontal and 30 degrees vertical field of view.		30 degrees vertical field of view may be insufficient to meet the requirements of AC No. 1 to YCAR-STD 1A.030 Table 2.3 paragraph 4.c (visual ground segment)	✓	✓		

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
(2) System geometry	5° even angular spacing within ± 1° as measured from either pilot eye-point, and within 1·5° for adjacent squares.	Not Applicable	System geometry should 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 light points at the intersections. The operator should 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.	✓	✓	✓	✓
(3) Surface Contrast Ratio	Not less than 5:1	Not Applicable	Surface contrast ratio should be measured using a raster drawn test pattern filling the entire visual scene (all channels). The test pattern should consist of black and white squares, 5 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 1° spot photometer. This value should have a minimum brightness of 7 cd/m2 (2 foot-lamberts). Measure any adjacent dark squares. The contrast ratio is the bright square value divided by the dark square value. Note. During contrast ratio testing, simulator aft-cab and flight deck ambient light levels should be zero.			✓	✓

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
(4) Highlight Brightness	Not less than 20 cd/m^2 (6 ft-lamberts) on the display	Not Applicable	Highlight brightness should be measured by maintaining the full test pattern described in paragraph 4.b 3) above, superimposing a highlight on the centre white square of each channel and measuring the brightness using the 1° spot photometer. Lightpoints are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable.			✓	✓
(5) Vernier Resolution	Not greater than 2 arc minutes	Not Applicable	Vernier resolution should 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. The eye will subtend two arc minutes (arc tan (4/6 876)x60) when positioned on a 3 degree glideslope, 6 876 ft slant range from the centrally located threshold of a black runway surface painted with white threshold bars that are 16 ft wide with 4-ft gaps in-between. This should be confirmed by calculations in a statement of compliance.			✓	✓
(6) Lightpoint Size	Not greater than 5 arc minutes.	Not Applicable	Lightpoint size should 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. A row of 48 lights will form a 4° angle or less.			✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
(7) Lightpoint Contrast Ratio.	Not less than 10:1 Not less than 25:1	Not Applicable	Lightpoint contrast ratio should be measured using a test pattern demonstrating a 1° area filled with lightpoints (i.e. lightpoint modulation just discernible) and should be compared to the adjacent background. Note. During contrast ratio testing, simulator aft-cab and flight deck ambient light levels should be zero.	✓	✓	✓	✓
c. VISUAL GROUND SEGMENT Visual Ground Segment.	Near end. The lights computed to be visible should be visible in the flight simulator. Far end: ± 20% of the computed VGS	Trimmed in the landing configuration at 30 m (100 ft) wheel height above touchdown zone elevation on glide slope at a RVR setting of 300 m (1 000 ft) or 350m (1 200ft)	Visual Ground Segment. 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 1) RVR, 2) glideslope (G/S) and localiser modelling accuracy (location and slope) for an ILS, 3) for a given weight, configuration and speed representative of a point within the aeroplane's operational envelope for a normal approach and landing. If non-homogenous fog is used, the vertical variation in horizontal visibility should be described and be included in the slant range visibility calculation used in the VGS computation.	✓	✓	✓	✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
5. SOUND SYSTEMS			All tests in this section should be presented using an unweighted 1/3-octave band format from band 17 to 42 (50 Hz to 16 kHz). A minimum 20 second average should be taken at the location corresponding to the aeroplane data set. The aeroplane and flight simulator results should be produced using comparable data analysis techniques. See AC STD 1A.030 para 2.4.5				
a. Turbo-jet aeroplanes							
(1) Ready for engine start	± 5 dB per 1/3 octave band	Ground	Normal condition prior to engine start. The APU should be on if appropriate.				✓
(2) All engines at idle	± 5 dB per 1/3 octave band	Ground	Normal condition prior to take-off.				✓
(3) All engines at maximum allowable thrust with brakes set	± 5 dB per 1/3 octave band	Ground	Normal condition prior to take-off.				✓
(4) Climb	± 5 dB per 1/3 octave band	En-route climb	Medium altitude.				✓
(5) Cruise	± 5 dB per 1/3 octave band	Cruise	Normal cruise configuration.				✓
(6) Speedbrake/spoilers extended (as appropriate)	± 5 dB per 1/3 octave band	Cruise	Normal and constant speedbrake deflection for descent at a constant airspeed and power setting.				✓
(7) Initial approach	± 5 dB per 1/3 octave band	Approach	Constant airspeed, gear up, flaps/slats as appropriate.				✓
(8) Final approach	± 5 dB per 1/3 octave band	Landing	Constant airspeed, gear down, full flaps.				✓

Test	Tolerance	Flight Condition	Comments	Level			
				A	B	C	D
b. Propeller aeroplanes							
(1) Ready for engine start	± 5 dB per 1/3 octave band	Ground	Normal condition prior to engine start. The APU should be on if appropriate.				✓
(2) All propellers feathered	± 5 dB per 1/3 octave band	Ground	Normal condition prior to take-off.				✓
(3) Ground idle or equivalent	± 5 dB per 1/3 octave band	Ground	Normal condition prior to take-off.				✓
(4) Flight idle or equivalent	± 5 dB per 1/3 octave band	Ground	Normal condition prior to take-off.				✓
(5) All engines at maximum allowable power with brakes set	± 5 dB per 1/3 octave band	Ground	Normal condition prior to take-off.				✓
(6) Climb	± 5 dB per 1/3 octave band	En-route climb	Medium altitude.				✓
(7) Cruise	± 5 dB per 1/3 octave band	Cruise	Normal cruise configuration.				✓
(8) Initial approach	± 5 dB per 1/3 octave band	Approach	Constant airspeed, gear up, flaps extended as appropriate, RPM as per operating manual.				✓
(9) Final approach	± 5 dB per 1/3 octave band	Landing	Constant airspeed, gear down, full flaps, RPM as per operating manual.				✓
c. Special cases	± 5 dB per 1/3 octave band	-	Special cases identified as particularly significant to the pilot, important in training, or unique to a specific aeroplane type or model.				✓

Test	Tolerance	Flight Condition	Comments	Level A	Level B	Level C	Level D
d. Flight simulator background noise	Initial evaluation: not applicable. Recurrent evaluation: ± 3dB per 1/3 octave band compared to initial evaluation	-	Results of the background noise at initial qualification should be included in the QTG document and approved by the qualifying authority. The simulated sound will be evaluated to ensure that the background noise does not interfere with training. Refer to AC STD 1A.030 para 2.4.5.6. The measurements are to be made with the simulation running, the sound muted and a dead cockpit.				✓
e. Frequency response	Initial evaluation: not applicable. Recurrent evaluation: cannot exceed ± 5 dB on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	-	Only required if the results are to be used during recurrent evaluations according to AC STD 1A.030 para 2.4.5.7. The results shall be acknowledged by the authority at initial qualification.			✓	✓

2.4 Information for Validation Tests

2.4.1 Control dynamics

2.4.1.1 General

The characteristics of an aeroplane flight control system have a major effect on handling qualities. A significant consideration in pilot acceptability of an aeroplane is the 'feel' provided through the flight controls. Considerable effort is expended on aeroplane feel system design so that pilots will be comfortable and will consider the aeroplane desirable to fly. In order for a flight simulator to be representative, it too should present the pilot with the proper feel – that of the aeroplane being simulated. Compliance with this requirement should be determined by comparing a recording of the control feel dynamics of the flight simulator to actual aeroplane measurements in the take-off, cruise, and landing configurations.

a. 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 flight simulator control loading system to the aeroplane systems is essential. The required dynamic control checks are indicated in AC No. 1 to YCAR-STD 1A.030, paragraph 2.3–2b(1) to (3) within the table of flight simulator validation tests.

b. For initial and upgrade evaluations, it is required that control dynamics characteristics 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.

c. For aeroplanes with irreversible control systems, measurements may be obtained on the ground if proper pitot-static inputs are provided to represent airspeeds typical of those encountered in flight. Likewise, it may be shown that for some aeroplanes, take-off, cruise, and landing configurations have like effects. Thus, one may suffice for another. If either or both considerations apply, engineering validation or aeroplane manufacturer rationale should be submitted as justification for ground tests or for eliminating a configuration. For flight simulators requiring static and dynamic tests at the controls, special test fixtures will 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.

2.4.1.2Control 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 texts on control systems. In order to establish a consistent means of validating test results for flight simulator control loading, criteria are needed that will 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.

a. Tests to verify that control feel dynamics represent the aeroplane should show that the dynamic damping cycles (free response of the controls) match that of the aeroplane within specified tolerances. The method of evaluating the response and the tolerance to be applied is described in the underdamped and critically damped cases are as follows:

1. Underdamped Response.

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 will be independently compared with the respective period of the aeroplane control system and, consequently, will enjoy the full tolerance specified for that period.

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 A_d from the steady state value of the oscillation. Only oscillations outside the residual band are considered significant. When comparing flight simulator data to aeroplane data, the process should begin by overlaying or aligning the flight simulator and aeroplane steady state values and then comparing amplitudes of oscillation peaks, the time of the first zero crossing, and individual periods of oscillation. The flight simulator should show the same number of significant overshoots to within one when compared against the aeroplane data. This procedure for evaluating the response is illustrated in Figure 1 below.

2. Critically damped and overdamped response. Due to the nature of critically damped and overdamped responses (no overshoots), the time to reach 90% of the steady state (neutral point) value should be the same as the aeroplane within ± 10%. Figure 2 illustrates the procedure.

3. Special considerations. Control systems, which 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.

b. Tolerances. The following table summarises the tolerances, T. See figures 1 and 2 for an illustration of the referenced measurements.

$T(P_0)$	± 10% of P_0
$T(P_1)$	± 20% of P_1
$T(P_2)$	± 30% of P_2
$T(P_n)$	± 10(n+1)% of P_n
$T(A_n)$	± 10% of A_1
$T(A_d)$	± 5% of A_d = residual band
Significant overshoots	First overshoot and ± 1 subsequent overshoots

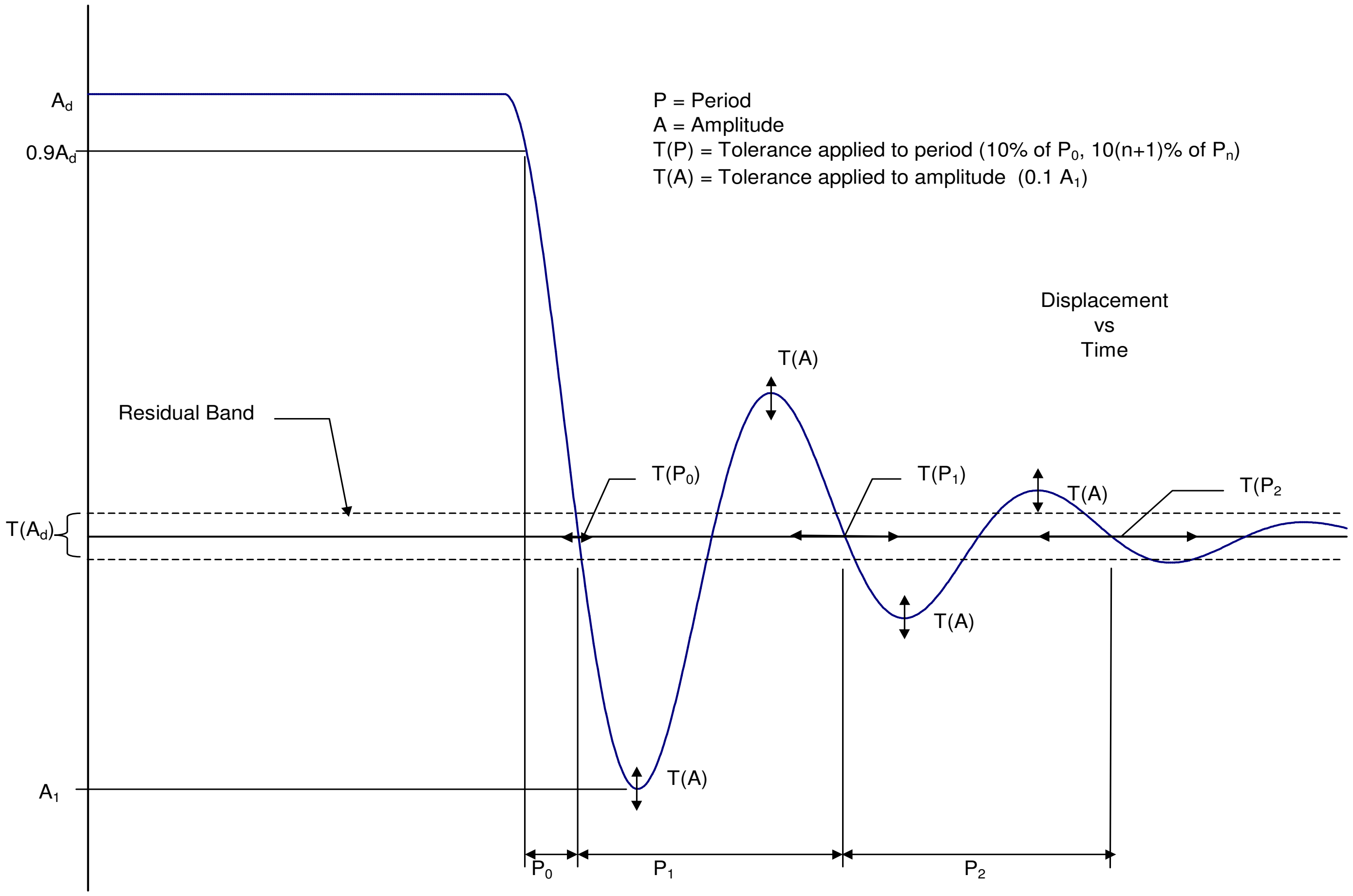

Figure 1 : Underdamped step response

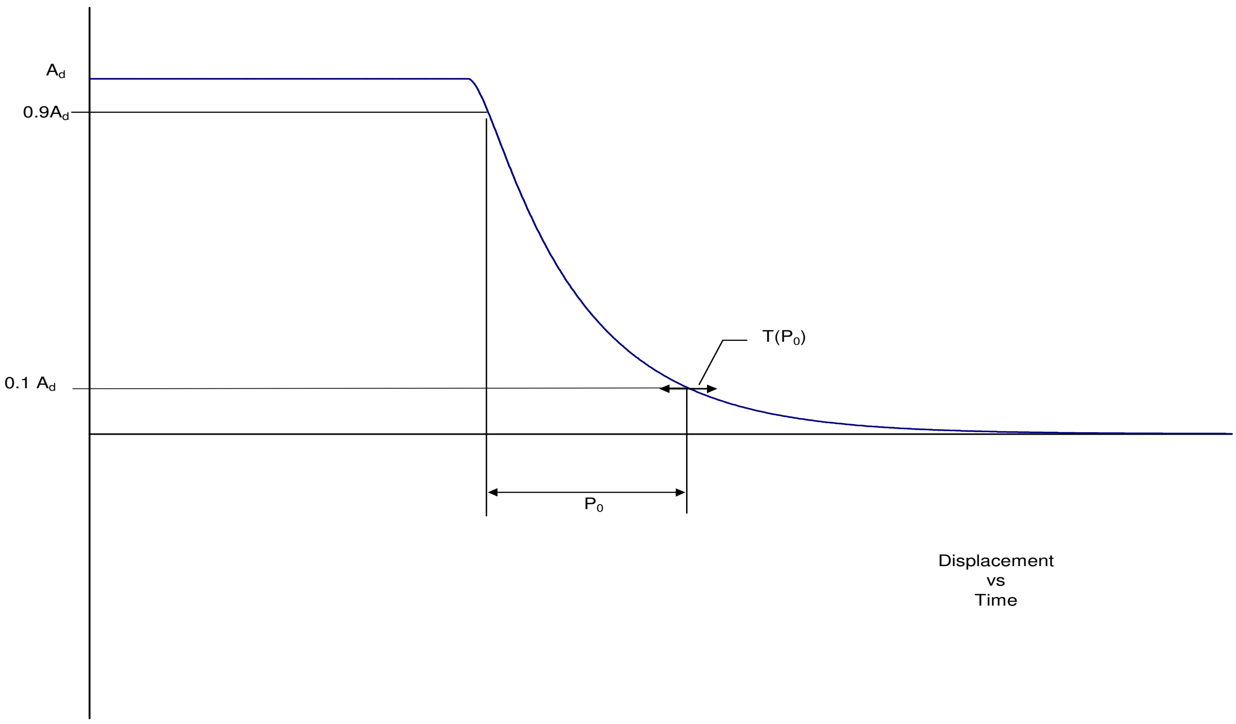

Figure 2 : Critically damped step response

2.4.1.3Alternate method for control dynamics evaluation.

One aeroplane manufacturer has proposed, and his the Authority has accepted, an alternate means for dealing with control dynamics. The method applies to aeroplanes with hydraulically powered flight controls and artificial feel systems. Instead of free response measurements, the system would be validated by measurements of control force and rate of movement.

a. For each axis of pitch, roll, and yaw, the control should be forced to its maximum extreme position for the following distinct rates. These tests should be conducted at typical taxy, take-off, cruise, and landing conditions.

1. Static test – Slowly move the control such that approximately 100 seconds are required to achieve a full sweep. A full sweep is defined as movement of the controller from neutral to the stop, usually aft or right stop, then to the opposite stop, then to the neutral position.

2. Slow dynamic test – Achieve a full sweep in approximately 10 seconds.

3. Fast dynamic test – Achieve a full sweep in approximately 4 seconds.

Note: Dynamic sweeps may be limited to forces not exceeding 44·5 daN (100 lbs).

b. Tolerances

1. Static test – AC No.1 to YCAR-STD 1A.030, paragraph 2.3 – 2.a(1), (2), and (3) of the table of flight simulator validation tests.

2. Dynamic test – ± 0·9 daN (2 lbs) or ± 10% on dynamic increment above static test.

c. The Authority is open to alternative means such as the one 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 aeroplanes with reversible control systems. Hence, each case should be considered on its own merit on an ad hoc basis. Should the Authority find that alternative methods do not result in satisfactory performance, then more conventionally accepted methods should be used.

2.4.2 Ground Effect

2.4.2.1 For a flight simulator to be used for take-off and landing it should faithfully reproduce the aerodynamic changes which occur in ground effect. The parameters chosen for flight simulator validation should be indicative of these changes.

A dedicated test should be provided which will validate the aerodynamic ground effect characteristics.

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.

2.4.2.2 Acceptable tests for validation of ground effect include:

a. Level fly-bys. The level fly-bys 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. Level B flight simulators may use methods other than the level fly-by method.

b. Shallow approach landing. The shallow approach landing should be performed at a glide slope of approximately one degree with negligible pilot activity until flare.

If other methods are proposed, rationale should be provided to conclude that the tests performed validate the ground-effect model.

2.4.2.3 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 flight simulator validation. In fact, 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 flight simulator modelling. Several tests such as 'crosswind landing', 'one engine inoperative landing', and '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.

2.4.3 Motion System

2.4.3.1 General

a. Pilots use continuous information signals to regulate the state of the aeroplane. In concert with the instruments and outside-world visual information, whole-body motion feedback is essential in assisting the pilot to control the aeroplane'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 aeroplane during a prescribed minimum set of manoeuvres and conditions. Moreover, the response of the motion cueing system should be repeatable.

b. The objective validation tests presented in this paragraph are intended to qualify the flight simulator motion cueing system from a mechanical performance standpoint. Additionally, the list of motion effects provides a representative sample of dynamic conditions that should be present in the flight simulator. A list of representative training-critical manoeuvres that should be recorded during initial qualification (but without tolerance) to indicate the flight simulator motion cueing performance signature has been added to this document. These are intended to help to improve the overall standard of flight simulator motion cueing.

2.4.3.2 Motion System Checks.

The intent of tests as described in the table of flight simulator validation tests, AC STD 1A.030, paragraph 2.3 - 3.a, frequency response, 3.b leg balance, and c, turn-around check 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 should be considered as robotic tests.

2.4.3.3 Motion Cueing Performance Signature

a. Background. The intent of this test is to provide quantitative time history records of motion system response to a selected set of automated QTG manoeuvres during initial qualification. This is not intended to be a comparison of the motion platform accelerations against the flight test recorded accelerations (i.e. not to be compared against aeroplane cueing). This information describes a minimum set of manoeuvres and a guideline for determining the flight simulator's motion footprint. If over time there is a change to the initially certified motion software load or motion hardware then these baseline tests should be rerun.

b. List of tests. Table 1 delineates those tests that are important to pilot motion cueing and are general tests applicable to all types of aeroplanes and thus the motion cueing performance signature should be run for initial qualification. These tests can be run at any time deemed acceptable to the Authority prior to or during the initial qualification. The tests in table 2 are also significant to pilot motion cues and are provided for information only. These tests are not required to be run.

c. Priority. A priority (X) is given to each of these manoeuvres, with the intent of placing greater importance on those manoeuvres that directly influence pilot perception and control of the aeroplane motions. For the manoeuvres designated with a priority in the tables below, the flight simulator motion cueing system should have a high tilt co-ordination gain, high rotational gain, and high correlation with respect to the aeroplane simulation model.

d. Data Recording. The minimum list of parameters provided should allow for the determination of the flight simulator's motion cueing performance signature for the initial qualification. The following parameters are recommended as being acceptable to perform such a function:

1. flight model acceleration and rotational rate commands at the pilot reference point;

2. motion actuators position;

3. actual platform position;

4. actual platform acceleration at pilot reference point.

2.4.3.4 Motion System Repeatability.

The intent of this test is to ensure that the motion system software and motion system hardware have not degraded or changed over time. This diagnostic test should be run during recurrent checks in lieu of the robotic tests. This will allow an improved ability to determine changes in the software or determine degradation in the hardware that have adversely affected the training value of the motion as was accepted during the initial qualification. The following information delineates the methodology that should be used for this test.

a. Conditions:

1. One test case on-ground: to be determined by the operator;

2. One test case In-flight: to be determined by the operator.

b. Input: The inputs should 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 5deg/sec/sec, 10deg/sec and 0·3g respectively to provide adequate analysis of the output.

c. Recommended output:

1. actual platform linear accelerations; the output will comprise accelerations due to both the linear and rotational motion acceleration;

2. motion actuators position

No.	Associated validation test	Manoeuvre	Priority	Comments
1	1b4	Take-off rotation (Vr to V2)	X	Pitch attitude due to initial climb should dominate over cab tilt due to longitudinal acceleration.
2	1b5	Engine failure between V1 and Vr	X	
3	2e6	Pitch change during go-around	X	
4	2c2 & 2c4	Configuration changes	X	
5	2c1	Power change dynamics	X	Resulting effects of power changes
6	2e1	Landing flare	X	
7	2e1	Touchdown bump		

Table 1 – Tests required for initial qualification

No.	Associated validation test	Manoeuvre	Priority	Comments
8	1a2	Taxi (including acceleration, turns, braking), with presence of ground rumble	X	
9	1b4	Brake release and initial acceleration	X	
10	1b1 & 3g	Ground rumble on runway, acceleration during take off, scuffing, runway lights and surface discontinuities	X	Scuffing and velocity cues are given priority
11	1b2 & 1b7	Engine failure prior to V1 (RTO)	X	Lateral and directional cues are given priority
12	1c1	Steady-state climb	X	
13	1d1& 1d2	Level flight acceleration and deceleration		
14	2c6	Turns	X	
15	1b8	Engine failures		
16	2c8	Stall characteristics	X	
17		System failures	X	Priority depending on the type of system failure and aeroplane type (e.g. flight controls failures, rapid decompression, inadvertent thrust reverser deployment)
18	2g1 & 2e3	Wind shear/crosswind landing	X	Influence on vibrations and on attitude control
19	1e1	Deceleration on runway		Including contamination effects

Table 2 – Tests that are significant but are not required to be run

2.4.3.5 Motion vibrations

a. Presentation of results. The characteristic motion vibrations are a means to verify that the flight simulator can reproduce the frequency content of the aeroplane when flown in specific 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 aeroplane data and flight simulator data should be presented in the same format with the same scaling. The algorithms used for generating the flight

simulator data should be the same as those used for the aeroplane data. If they are not the same then the algorithms used for the flight simulator 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. 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 flight simulator 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, a rationale should be provided to explain that the characteristic motion vibration is not being adversely affected by the filtering. The amplitude should match aeroplane data as per the description below; however, if for subjective reasons the PSD plot was altered a rationale should be provided to justify the change. If the plot is on a logarithmic scale it may be difficult to interpret the amplitude of the buffet in terms of acceleration. A $1x10^{-3}$ $grms^2/Hz$ would describe a heavy buffet and may be seen in the deep stall regime. On the other hand, a $1x10^{-6}$ $grms^2/Hz$ buffet is almost not perceivable; but may represent a flap buffet at low speed. The previous two examples differ in magnitude by 1 000. 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.).

2.4.4.1Visual system

a. Contrast ratio (daylight systems). 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 5 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 1 degree spot photometer. This value should have a minimum brightness of 7 cd/m^2 (2 foot-Lamberts). Measure any adjacent dark squares. The contrast ratio is the bright square value divided by the dark square value. Minimum test contrast ratio result is 5:1. Light point contrast ratio should be not less than 25:1 when a square of at least 1 degree filled (i.e. lightpoint modulation is just discemible) when lightpoints are compared to the adjacent background.

b. Highlight brightness test (daylight systems). Should be demonstrated by maintaining the full test pattern described above, the superimposing a highlight on the centre white square of each channel and measure the brightness using the 1 degree spot photometer. The highlight brightness should not be less than 6 ft-lamberts. Lightpoints are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable.

c. Resolution (daylight systems) should be demonstrated by a test of objects shown to occupy a visual angle of not greater than 2 arc minutes in the visual scene from the pilot's eyepoint. This should be confirmed by calculations in the statement of compliance.

d. Lightpoint size (daylight systems) – of not greater than 5 arc minutes should be measured in a test pattern consisting of a single row of lightpoints reduced in length until modulation is just discernible. A row of 48 lights will form a 4 degree angle or less.

e. Lightpoint size (twilight and night systems) – of sufficient resolution so as to enable achievement of visual feature recognition tests according to AC STD-1A.030, paragraph 3.3.m.(4).

2.4.4.2 Visual ground segment

(a) 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 G/S) of the simulated aeroplane can be readily determined using approach/runway lighting and flight deck instruments.

(b) The QTG should indicate the source of data, i.e. airport and runway used, ILS G/S antenna location (airport and aeroplane), pilot eye reference point, flight deck cut-off angle, etc., used to make accurately visual ground segment (VGS) scene content calculations.

(c) Automatic positioning of the simulated aeroplane on the ILS is encouraged. If such positioning is accomplished, diligent care should be taken to ensure the correct spatial position and aeroplane

attitude is achieved. Flying the approach manually or with an installed autopilot should also produce acceptable results.

2.4.5 Sound System

2.4.5.1 General. The total sound environment in the aeroplane is very complex, and changes with atmospheric conditions, aeroplane 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 flight simulator should provide flight deck sounds that are perceptible to the pilot during normal and abnormal operations, and that are comparable to those of the aeroplane. Accordingly, the flight simulator operator should carefully evaluate background noises in the location being considered. To demonstrate compliance with the sound requirements, the objective or validation tests in this paragraph have been selected to provide a representative sample of normal static conditions typical of those experienced by a pilot.

2.4.5.2 Alternate propulsion. For flight simulators with multiple propulsion configurations any condition listed in AC STD 1A.030, paragraph 2.3, the table of flight simulator validation tests, that is identified by the aeroplane manufacturer as significantly different, due to a change in propulsion system (engine or propeller), should be presented for evaluation as part of the QTG.

2.4.5.3 Data and Data Collection System

(a) Information provided to the flight simulator manufacturer should comply with "IATA Flight Simulator Design & Performance Data Requirements", 6th Edition, 2000. This information should contain calibration and frequency response data.

(b) The system used to perform the tests listed in AC No. 1 to YCAR-STD 1A.030, para.2.3, within the table of flight simulator validation tests, should comply with the following standards:

(1) ANSI S1.11-1986 - Specification for octave, half octave and third octave band filter sets;

(2) IEC 1094-4 - 1995 - measurement microphones - type WS2 or better.

2.4.5.4 Headsets. If headsets are used during normal operation of the aeroplane they should also be used during the flight simulator evaluation.

2.4.5.5 Playback equipment. Playback equipment and recordings of the QTG conditions according to AC No.1 to YCAR-STD 1A.030, paragraph 2.3, table of flight simulator validation tests, should be provided during initial evaluations.

2.4.5.6 Background noise

(a) Background noise is the noise in the flight simulator due to the flight simulator's cooling and hydraulic systems that is not associated with the aeroplane, and the extraneous noise from other locations in the building. Background noise can seriously impact the correct simulation of aeroplane sounds, so the goal should be to keep the background noise below the aeroplane 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.

(b) The acceptability of the background noise levels is dependent upon the normal sound levels in the aeroplane being represented. Background noise levels that fall below the lines defined by the following points, may be acceptable (refer to figure 3):

(1) 70 dB @ 50 Hz;

(2) 55 dB @ 1 000 Hz;

(3) 30 dB @ 16 kHz.

These limits are for unweighted 1/3 octave band sound levels. Meeting these limits for background noise does not ensure an acceptable flight simulator. Aeroplane sounds, which fall below this limit require careful review and may require lower limits on the background noise.

(c) The background noise measurement may be rerun at the recurrent evaluation as per paragraph 2.4.5.8. The tolerances to be applied are as follows:

(1) recurrent 1/3 octave band amplitudes cannot exceed ± 3 dB when compared to the initial results.

2.4.5.7 Frequency response - Frequency response plots for each channel should be provided at initial evaluation. These plots may be rerun at the recurrent evaluation as per AC STD 1A.030, paragraph 2.4.5.8. The tolerances to be applied are as follows:

(a) recurrent 1/3 octave band amplitudes cannot exceed ± 5 dB for three consecutive bands when compared to initial results.

(b) the average of the sum of the absolute differences between initial and recurrent results cannot exceed 2 dB (refer table 3).

2.4.5.8 Initial and recurrent evaluations. If recurrent frequency response and flight simulator background noise results are within tolerance, respective to initial evaluation results, and the operator can prove that no software or hardware changes have occurred that will affect the aeroplane cases, then it is not required to rerun those cases during recurrent evaluations.
If aeroplane cases are rerun during recurrent evaluations then the results may be compared against initial evaluation results rather than aeroplane master data.

2.4.5.9 Validation testing. Deficiencies in aeroplane recordings should be considered when applying the specified tolerances to ensure that the simulation is representative of the aeroplane. Examples of typical deficiencies are:

(a) variation of data between tail numbers;

(b) frequency response of microphones;

(c) repeatability of the measurements;

(d) extraneous sounds during recordings.

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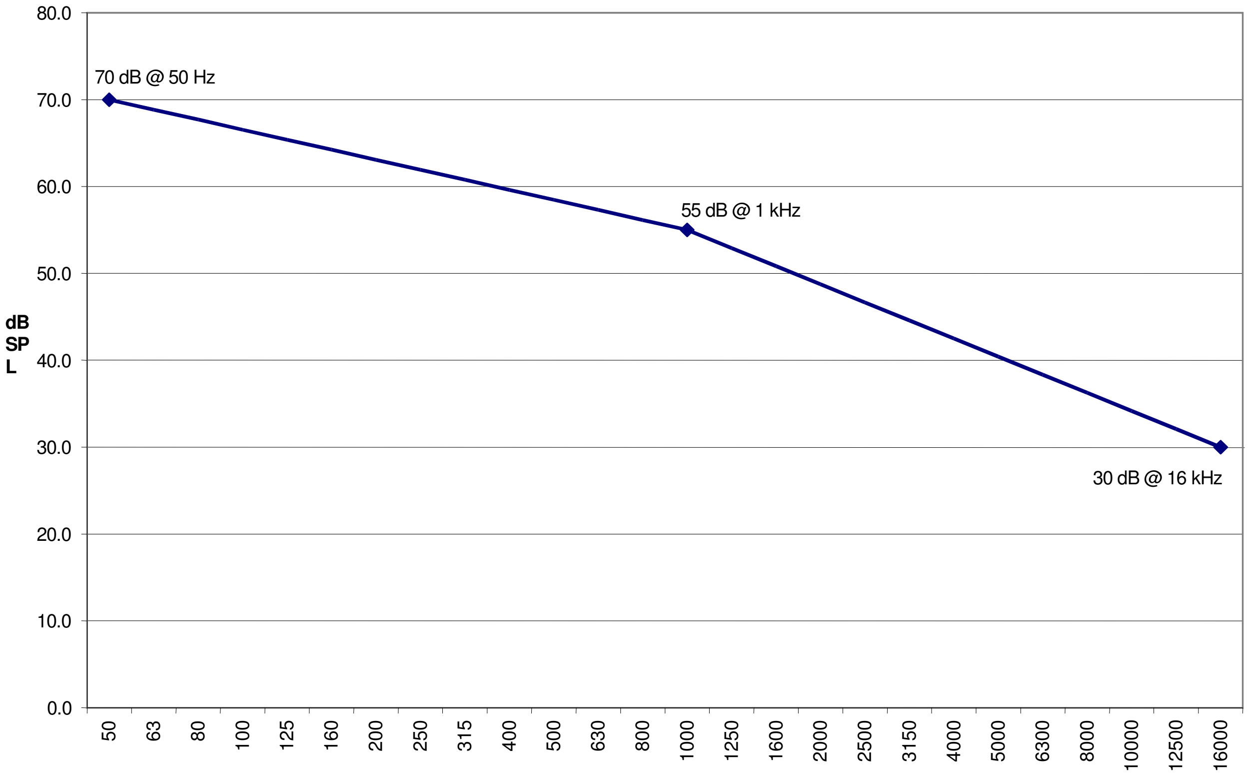

Figure 3. 1/3 Octave Band Frequency (Hz)

Table 3 - 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

3 Functions and Subjective Tests

3.1 Discussion

3.1.1 Accurate replication of aeroplane systems functions will be checked at each flight crewmember position. This includes procedures using the operator's approved manuals, aeroplane manufacturers approved manuals and checklists. A useful source of guidance for conducting the tests required to establish that the critieria set out in this document are complied with by the flight simulator under evaluation are published in the RAeS Airplane Flight Simulator Evaluation Handbook. Handling qualities, performance, and flight simulator systems operation will be subjectively assessed. In order to assure the functions tests are conducted in an efficient and timely manner, operators are encouraged to coordinate with the appropriate Authority responsible for the evaluation so that any skills, experience or expertise needed by the Authority in charge of the evaluation team are available.

3.1.2 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 aeroplane. Unlike the objective tests listed in paragraph 2 above, the subjective testing should cover those areas of the flight envelope which may reasonably be reached by a trainee, even though the flight simulator has not been approved for training in that area. Thus it is prudent to examine, for example, the normal and abnormal flight simulator performance to ensure that the simulation is representative even though it may not be a requirement for the level of qualification being sought. (Any such subjective assessment of the simulation should include reference to paragraph 2 and 3 above in which the minimum objective standards acceptable for that Level are defined. In this way it is possible to determine whether simulation is an absolute requirement or just one where an approximation, if provided, has to be checked to confirm that it does not contribute to negative training.)

3.1.3 At the request of the Authority, the flight simulator may be assessed for a special aspect of an operator's training programme during the functions and subjective portion of an evaluation. Such an assessment may include a portion of a Line Oriented Flight Training (LOFT) scenario or special emphasis items in the operator's training programme. Unless directly related to a requirement for the current Qualification Level, the results of such an evaluation would not affect the flight simulator's current status.

3.1.4 Functions tests will be run in a logical flight sequence at the same time as performance and handling assessments. This also permits real time flight simulator running for 2 to 3 hours, without repositioning or flight or position freeze, thereby permitting proof of reliability.

3.2 Test requirements

3.2.1 The ground and flight tests and other checks required for qualification are listed in the table of functions and subjective tests. The table includes manoeuvres and procedures to assure that the flight simulator functions and performs appropriately for use in pilot training, testing and checking in the manoeuvres and procedures normally required of a training, testing and checking programme.

3.2.2 Manoeuvres and procedures are included to address some features of advanced technology aeroplanes and innovative training programmes. For example, 'high angle of attack manoeuvring' is included to provide an alternative to 'approach to stalls'. Such an alternative is necessary for aeroplanes employing flight envelope limiting technology.

3.2.3 All systems functions will be assessed for normal and, where appropriate, alternate operations. Normal, abnormal, and emergency procedures associated with a flight phase will be assessed during the evaluation of manoeuvres or events within that flight phase. Systems are listed separately under 'any flight phase' to assure appropriate attention to systems checks.

3.2.4 When evaluating functions and subjective tests, the fidelity of simulation required for the highest level of qualification should be very close to the aeroplane. However, for the lower levels of qualification the degree of fidelity may be reduced in accordance with the criteria contained in paragraph 2 above.

3.3 Functions and subjective tests

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
a. **PREPARATION FOR FLIGHT**				
(1) Pre-flight. Accomplish a functions check of all switches, indicators, systems, and equipment at all crewmembers' and instructors' stations and determine that the flight deck design and functions are identical to that of the aeroplane simulated.	✓	✓	✓	✓
b. **SURFACE OPERATIONS (PRE-TAKE-OFF)**	✓	✓	✓	✓
(1) Engine Start				
(a) Normal start.				
(b) Alternate start procedures.				
(c) Abnormal starts and shutdowns (hot start, hung start, tail pipe fire, etc.).				
(2) Pushback/Powerback.				
(3) Taxi				
(a) Thrust response.				
(b) Power lever friction.				
(c) Ground handling.				
(d) Nose wheel scuffing.				
(e) Brake operation (normal and alternate/emergency).				
I. Brake fade (if applicable)				
II. Other				
c. **TAKE-OFF**	✓	✓	✓	✓
(1) Normal				
(a) Aeroplane/engine parameter relationships.				
(b) Acceleration characteristics (motion).				
(c) Nose wheel and rudder steering.				
(d) Crosswind (maximum demonstrated).				
(e) Special performance (e.g. reduced V1, max de-rate, short field operations).				
(f) Low visibility take-off.				
(g) Landing gear, wing flap leading edge device operation.				
(h) Contaminated runway operation.				
(i) Other.				

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
(2) Abnormal/emergency. (a) Rejected. (b) Rejected special performance (e.g. reduced V_1, max de-rate, short field operations). (c) With failure of most critical engine at most critical point, continued take-off. (d) With wind shear. (e) Flight control system failures, reconfiguration modes, manual reversion and associated handling. (f) Rejected, brake fade. (g) Rejected, contaminated runway. (h) Other.	✓	✓	✓	✓
d. **CLIMB** (1) Normal. (2) One or more engines inoperative. (3) Other.	✓	✓	✓	✓
e. **CRUISE** (1) Performance characteristics (speed vs. power). (2) High altitude handling. (3) High Mach number handling (Mach tuck, Mach buffet) and recovery (trim change). (4) Overspeed warning (in excess of Vmo or Mmo) (5) High IAS handling.	✓	✓	✓	✓
f. **MANOEUVRES** (1) High angle of attack, approach to stalls, stall warning, buffet, and g-break (take-off, cruise, approach, and landing configuration). (2) Flight envelope protection (high angle of attack, bank limit, overspeed, etc). (3) Turns with/without speedbrake/spoilers deployed. (4) Normal and steep turns (5) Performance turns (6) In flight engine shutdown and restart (assisted and windmill). (7) Manoeuvring with one or more engines inoperative, as appropriate. (8) Specific flight characteristics (e.g. direct lift control). (9) Flight control system failures, reconfiguration modes, manual reversion and associated handling. (10) Other.	✓	✓	✓	✓
g. **DESCENT** (1) Normal. (2) Maximum rate (clean and with speedbrake, etc). (3) With autopilot. (4) Flight control system failures, reconfiguration modes, manual reversion and associated handling. (5) Other.	✓	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
h. **INSTRUMENT APPROACHES AND LANDING** Only those instrument approach and landing tests relevant to the simulated aeroplane type should be selected from the following list, where tests should be made with limiting wind velocities, wind shear and with relevant system failures, including the use of Flight Director.				
(1) Precision. (i) PAR (ii) CAT I/GBAS (ILS/MLS) published approaches A Manual approach with/without flight director including landing. B Autopilot/autothrottle coupled approach and manual landing. C Manual approach to DH and G/A all engines. D Manual one engine out approach to DH and G/A. E Manual approach controlled with and without flight director to 30 m (100 ft) below CAT I minima (i) with cross-wind (maximum demonstrated) (ii) with wind shear F Autopilot/autothrottle coupled approach, one engine out to DH and G/A. G Approach and landing with minimum/standby electrical power. (ii) CAT II/GBAS (ILS/MLS) published approaches. A Autopilot/autothrottle coupled approach to DH and landing. B Autopilot/autothrottle coupled approach to DH and G/A. C Autocoupled approach to DH and manual G/A. D Category II published approach (i) auto-coupled, autothrottle (iii) CAT III/GBAS (ILS/MLS) published approaches. A Autopilot/autothrottle coupled approach to land and rollout. B Autopilot/autothrottle coupled approach to DH/Alert Height and G/A. C Autopilot/autothrottle coupled approach to land and rollout with one engine out. D Autopilot/autothrottle coupled approach to DH/Alert Height and G/A with one engine out. E Autopilot/autothrottle coupled approach (to land or to go around) (i) with generator failure (ii) with 10 knot tail wind (iii) with 10 knot crosswind	✓	✓	✓	✓
(2) Non-precision. (i) NDB. (ii) VOR, VOR/DME, VOR/TAC. (iii) RNAV (GNSS). (iv) ILS LLZ (LOC), LLZ(LOC)/BC. (v) ILS offset localizer (vi) direction finding facility (vii) surveillance radar	✓	✓	✓	✓
NOTE: If Standard Operating Procedures are to use autopilot for non-precision approaches then these should be evaluated.				

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL A	B	C	D
i. **VISUAL APPROACHES (SEGMENT) AND LANDINGS** (1) Manoeuvring, normal approach and landing all engines operating with and without visual approach aid guidance. (2) Approach and landing with one or more engines inoperative. (3) Operation of landing gear, flap/slats and speedbrakes (normal and abnormal). (4) Approach and landing with crosswind (max. demonstrated). (5) Approach to land with wind shear on approach. (6) Approach and landing with flight control system failures, reconfiguration modes, manual reversion and associated handling (most significant degradation which is probable). (7) Approach and landing with trim malfunctions. (i) longitudinal trim malfunction (ii) lateral-directional trim malfunction (8) Approach and landing with standby (minimum) electrical/hydraulic power (9) Approach and landing from circling conditions (circling approach). (10) Approach and landing from visual traffic pattern. (11) Approach and landing from non-precision approach (12) Approach and landing from precision approach (13) Approach procedures with vertical guidance (APV), e.g., SBAS (14) Other. NOTE: Flight simulators with visual systems, which permit completing a special approach procedure in accordance with applicable regulations, may be approved for that particular approach procedure.	✓	✓	✓	✓
j. **MISSED APPROACH** (1) All engines. (2) One or more engine(s) out. (3) With flight control system failures, reconfiguration modes, manual reversion and associated handling.	✓	✓	✓	✓
k. **SURFACE OPERATIONS (POST LANDING)** (1) Landing roll and taxi. (i) Spoiler operation. (ii) Reverse thrust operation. (iii) Directional control and ground handling, both with and without reverse thrust. (iv) Reduction of rudder effectiveness with increased reverse thrust (rear pod-mounted engines). (v) Brake and anti-skid operation with dry, wet, and icy conditions. (vi) Brake operation, to include auto-braking system where applicable. (vii) Other.	✓	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
I. **ANY FLIGHT PHASE**				
(1) Aeroplane and powerplant systems operation.	✓	✓	✓	✓
(i) Air conditioning and pressurisation (ECS).				
(ii) De-icing/anti-icing.				
(iii) Auxiliary powerplant/auxiliary power unit (APU).				
(iv) Communications.				
(v) Electrical.				
(vi) Fire and smoke detection and suppression.				
(vii) Flight controls (primary and secondary).				
(viii) Fuel and oil, hydraulic and pneumatic.				
(ix) Landing gear.				
(x) Oxygen.				
(xi) Powerplant.				
(xii) Airborne radar.				
(xiii) Autopilot and Flight Director.				
(xiv) Collision avoidance systems. (e.g. GPWS,TCAS)				
(xv) Flight control computers including stability and control augmentation.				
(xvi) Flight display systems.				
(xvii) Flight management computers.				
(xviii) Head-up guidance, head-up displays				
(xix) Navigation systems				
(xx) Stall warning/avoidance				
(xxi) Wind shear avoidance equipment				
(xxii) Automatic landing aids.				
(2) Airborne procedures.				
(i) Holding.	✓	✓	✓	✓
(ii) Air hazard avoidance. (traffic, weather)			✓	✓
(iii) Wind shear.			✓	✓
(3) Engine shutdown and parking.	✓	✓	✓	✓
(i) Engine and systems operation.				
(ii) Parking brake operation.				
(4) Other	✓	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
m. **VISUAL SYSTEM**				
(1) Functional test content requirements (Levels C and D) Note—The following is the minimum airport model content requirement to satisfy visual capability tests, and provides suitable visual cues to allow completion of all functions and subjective tests described in this appendix. STD operators are encouraged to use the model content described below for the functions and subjective tests. If all of the elements cannot be found at a single real world airport, then additional real world airports may be used. The intent of this visual scene content requirement description is to identify that content required to aid the pilot in making appropriate, timely decisions. (i) (ii) runway threshold elevations and locations shall be modeled to provide sufficient correlation with aeroplane systems (e.g., HGS, GPS, altimeter); slopes in runways, taxiways, and ramp areas should not cause distracting or unrealistic effects, including pilot eye-point height variation (iii) representative airport buildings, structures and lighting (iv) one useable gate, set at the appropriate height, for those aeroplanes that typically operate from terminal gates (v) representative moving and static gate clutter (e.g., other aeroplanes, power carts, tugs, fuel trucks, additional gates) (vi) representative gate/apron markings (e.g., hazard markings, lead-in lines, gate numbering) and lighting (vii) representative runway markings, lighting, and signage, including a wind sock that gives appropriate wind cues (viii) representative taxiway markings, lighting, and signage necessary for position identification, and to taxi from parking to a designated runway and return to parking; representative, visible taxi route signage shall be provided; a low visibility taxi route (e.g. Surface Movement Guidance Control System, follow-me truck, daylight taxi lights) should also be demonstrated (ix) representative moving and static ground traffic (e.g., vehicular and aeroplane) (x) representative depiction of terrain and obstacles within 25 NM of the reference airport (xi) representative depiction of significant and identifiable natural and cultural features within 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. (xii) representative moving airborne traffic (xiii) appropriate approach lighting systems and airfield lighting for a VFR circuit and landing, non-precision approaches and landings, and Category I, II and III precision approaches and landings (xiv) representative gate docking aids or a marshaller			✓	✓
(2) Functional test content requirements (Levels A and B) Note—The following is the minimum airport model content requirement to satisfy visual capability tests, and provides suitable visual cues to allow completion of all functions and subjective tests described in this appendix. STD operators are encouraged to use the model content described below for the functions and subjective tests. (i.) representative airport runways and taxiways (ii.) runway definition (iii.) runway surface and markings (iv.) lighting for the runway in use including runway edge and centreline lighting, visual approach aids and approach lighting of appropriate colours (v.) representative taxiway lights	✓	✓		

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
(3) Visual scene management (i) Runway and approach lighting intensity for any approach should be set at an intensity representative of that used in training for the visibility set; all visual scene light points should fade into view appropriately (ii) 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 should be realistically replicated.	✓	✓	✓	✓
(4)Visual feature recognition Note—Tests 3(i) through 3(v) below contain the minimum distances at which runway features should be visible. Distances are measured from runway threshold to an aeroplane aligned with the runway 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.				
(i) Runway definition, strobe lights, approach lights, and runway edge white lights from 8 km (5 sm) of the runway threshold.	✓	✓	✓	✓
(ii) Visual Approach Aids lights from 8 km (5 sm) of the runway threshold.			✓	✓
(iii) Visual Approach Aids lights from 5 km (3 sm) of the runway threshold.	✓	✓		
(iv) Runway centreline lights and taxiway definition from 5 km (3 sm).	✓	✓	✓	✓
(v) Threshold lights and touchdown zone lights from 3 km (2 sm).	✓	✓	✓	✓
(vi) Runway markings within range of landing lights for night scenes as required by the surface resolution test on day scenes.	✓	✓	✓	✓
(vii) For circling approaches, the runway of intended landing and associated lighting should fade into view in a non-distracting manner.	✓	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL A	B	C	D
(5)Airport model content Minimum of three specific airport scenes as defined below. (i) terminal approach area (a) accurate portrayal of airport features is to be consistent with published data used for aeroplane operations. (b) all depicted lights should be checked for appropriate colours, directionality, behaviour and spacing (e.g., obstruction lights, edge lights, centre line, touchdown zone, VASI, PAPI, REIL and strobes). (c) depicted airport lighting should be selectable via controls at the instructor station as required for aeroplane operation. (d) selectable airport visual scene capability at each model demonstrated for: (a) night (b) twilight (c) day (e) Ramps and terminal buildings which correspond to an operator's LOFT and LOS scenarios. (ii) terrain appropriate terrain, geographic and cultural features (iii) dynamic effects the capability to present multiple ground and air hazards such as another aeroplane crossing the active runway or converging airborne traffic; hazards should be selectable via controls at the instructor station (iv) illusions operational visual scenes which portray representative 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 specific aerodrome.			✓	✓
(6)Correlation with aeroplane and associated equipment				
(i) visual system compatibility with aerodynamic programming	✓	✓	✓	✓
(ii) visual cues to assess sink rate and depth perception during landings		✓	✓	✓
(iii) accurate portrayal of environment relating to flight simulator attitudes	✓	✓	✓	✓
(iv) the visual scene should correlate with integrated aeroplane systems, where fitted (e.g. terrain, traffic and weather avoidance systems and Head-up Guidance System (HGS))			✓	✓
(v) representative visual effects for each visible, ownship, aeroplane external light		✓	✓	✓
(vi) the effect of rain removal devices should be provided			✓	✓
(7)Scene quality				
(i) surfaces and textural cues should be free from apparent quantization (aliasing)			✓	✓
(ii) system capable of portraying full colour realistic textural cues			✓	✓
(iii) the system light points should be free from distracting jitter, smearing or streaking	✓	✓	✓	✓
(iv) demonstration of occulting through each channel of the system in an operational scene	✓	✓		
(v) demonstration of a minimum of ten levels of occulting through each channel of the system in an operational scene			✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
(vi) system capable of providing focus effects that simulate rain and light point perspective growth			✓	✓
(vii) system capable of six discrete light step controls (0-5)	✓	✓	✓	✓
(8)Environmental effects				
(i) the displayed scene should correspond to the appropriate surface contaminants and include runway lighting reflections for wet, partially obscured lights for snow, or suitable alternative effects			✓	✓
(ii) 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 aerodrome surface and within a radius of 16 km (10 sm) from the aerodrome			✓	✓
(iii) in - cloud effects such as variable cloud density, speed cues and ambient changes should be provided			✓	✓
(iv) the effect of multiple cloud layers representing few, scattered, broken and overcast conditions giving partial or complete obstruction of the ground scene			✓	✓
(v) gradual break-out to ambient visibility/RVR, defined as up to 10% of the respective cloud base or top, 20 ft ≤transition layer ≤200 ft; cloud effects should be checked at and below a height of 600 m (2 000 ft) above the aerodrome and within a radius of 16 km (10 sm) from the airport			✓	✓
(vi) visibility and RVR measured in terms of distance. Visibility/RVR should be checked at and below a height of 600 m (2 000 ft) above the aerodrome and within a radius of 16 km (10 sm.) from the airport	✓	✓	✓	✓
(vii) patchy fog giving the effect of variable RVR *Note – Patchy fog is sometimes referred to as patchy RVR.*			✓	✓
(viii) effects of fog on aerodrome lighting such as halos and defocus			✓	✓
(ix) effect of ownship lighting in reduced visibility, such as reflected glare, to include landing lights, strobes, and beacons			✓	✓
(x) wind cues to provide the effect of blowing snow or sand across a dry runway or taxiway should be selectable from the instructor station			✓	✓
(9)Instructor controls of:	✓	✓	✓	✓
(i) Environmental effects, e.g. cloud base, cloud effects, cloud density, visibility in kilometres/statute miles and RVR in metres/feet.				
(ii) Airport/aerodrome selection.				
(iii) Airport/aerodrome lighting including variable intensity.				
(iv) Dynamic effects including ground and flight traffic				
(10)Night visual scene capability.	✓	✓	✓	✓
(11)Twilight visual scene capability			✓	✓
(12)Daylight visual scene capability			✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
n. **MOTION EFFECTS** The following specific motion effects are required to indicate the threshold at which a flight crewmember should recognise an event or situation. Where applicable below, flight simulator pitch, side loading and directional control characteristics should be representative of the aeroplane as a function of aeroplane type: (1) Effects of runway rumble, oleo deflections, ground speed, uneven runway, runway centreline lights and taxiway characteristics. (a) After the aeroplane has been pre-set to the takeoff 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 should be affected by ground speed and runway roughness. If time permits, different gross weights can also be selected as this may also affect the associated vibrations depending on aeroplane type. The associated motion effects for the above tests should also include an assessment of the effects of centreline lights, surface discontinuities of uneven runways, and various taxiway characteristics.	*	✓	✓	✓
(2) Buffets on the ground due to spoiler/speedbrake extension and thrust (a) 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	*	✓	✓	✓
(3) Bumps associated with the landing gear. (a) 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.	*	✓	✓	✓
(4) Buffet during extension and retraction of landing gear. (a) Operate the landing gear. Check that the motion cues of the buffet experienced are reasonably representative of the actual aeroplane.	*	✓	✓	✓
(5) Buffet in the air due to flap and spoiler/speedbrake extension and approach to stall buffet (a) First perform an approach and extend the flaps and slats, especially with airspeeds deliberately in excess of the normal approach speeds. In cruise configuration verify the buffets associated with the spoiler/speedbrake extension. The above effects could also be verified with different combinations of speedbrake/flap/gear settings to assess the interaction effects.	*	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS		SIMULATOR LEVEL A	B	C	D
	(6) Approach to stall buffet (a) Conduct an approach-to-stall with engines at idle and a deceleration of 1 knot/second. Check that the motion cues of the buffet, including the level of buffet increase with decreasing speed, are reasonably representative of the actual aeroplane.	*	✓	✓	✓
	(7) Touchdown cues for main and nose gear. (a) Fly several normal approaches with various rates of descent. Check that the motion cues of the touchdown bump for each descent rate are reasonably representative of the actual aeroplane.	*	✓	✓	✓
	(8) Nose wheel scuffing. (a) Taxi the simulated aeroplane at various ground speeds and manipulate the nose wheel steering to cause yaw rates to develop which cause the nose wheel to vibrate against the ground (“scuffing”). Evaluate the speed/nose wheel combination needed to produce scuffing and check that the resultant vibrations are reasonably representative of the actual aeroplane.	*	✓	✓	✓
	(9) Thrust effect with brakes set. (a) 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. This effect is most discernible with wing mounted engines. Confirm that the buffet increases appropriately with increasing engine thrust	*	✓	✓	✓
	(10) Mach and manoeuvre buffet (a) 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.	*	✓	✓	✓
	(11) Tyre failure dynamics (a) Dependent on aeroplane type, a single tire failure may not necessarily be noticed by the pilot and therefore there should not be any special motion effect. There may possibly be some sound and/or vibration associated with the actual tire losing pressure. With a multiple tire failure selected on the same side the pilot may notice some yawing which should require the use of the rudder to maintain control of the aeroplane.			✓	✓

<table>
<tr><td colspan="2" rowspan="2">TABLE OF FUNCTIONS AND SUBJECTIVE TESTS</td><td colspan="4">SIMULATOR LEVEL</td></tr>
<tr><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td></td><td>(12) Engine malfunction and engine damage
(a) The characteristics of an engine malfunction as stipulated in the malfunction definition document for the particular flight simulator should describe the special motion effects felt by the pilot. The associated engine instruments should also vary according to the nature of the malfunction.</td><td>*</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td></td><td>(13) Tail strikes and pod strikes
(a) Tail-strikes can be checked by over-rotation of the aeroplane at a speed below V_r whilst performing a takeoff. The effects can also be verified during a landing. The motion effect should be felt as a noticeable bump. If the tail strike affects the aeroplane's angular rates, the cueing provided by the motion system should have an associated effect.
(b) Excessive banking of the aeroplane during its take-off/landing roll can cause a pod strike. The motion effect should be felt as a noticeable bump. If the pod strike affects the aeroplane's angular rates, the cueing provided by the motion system should have an associated effect.</td><td>*</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>o.</td><td>SOUND SYSTEM
(1) The following checks should be performed during a normal flight profile with motion
(a) precipitation
(b) rain removal equipment
(c) significant aeroplane noises perceptible to the pilot during normal operations
(d) abnormal operations for which there are associated sound cues including, but not limited to, engine malfunctions, landing gear/tire malfunctions, tail and engine pod strike and pressurization malfunction.
(e) sound of a crash when the flight simulator is landed in excess of limitations</td><td></td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>p.</td><td>SPECIAL EFFECTS
(1) Braking Dynamics
(a) representative brake failure dynamics (including antiskid) and decreased brake efficiency due to high brake temperatures based on aeroplane related data. These representations should be realistic enough to cause pilot identification of the problem and implementation of appropriate procedures. Flight simulator pitch, side-loading and directional control characteristics should be representative of the aeroplane.</td><td></td><td></td><td>✓</td><td>✓</td></tr>
<tr><td></td><td>(2) Effects of Airframe and Engine Icing
(a) See Appendix 1 to YCAR STD 1A.030 par 2.1(t).</td><td></td><td></td><td>✓</td><td>✓</td></tr>
<tr><td colspan="6">NOTE: For Level 'A', an asterisk (*) denotes that the appropriate effect is required to be present.</td></tr>
</table>

Appendix 1 to AC No. 1 to YCAR-STD 1A.030 (interpretative material)
Validation Test Tolerances

Background

1.1 The tolerances listed in AC No. 1 of YCAR-STD 1A.030 are designed to be a measure of quality of match using flight-test data as a reference.

1.2 There are many reasons, however, why a particular test may not fully comply with the prescribed tolerances:

(a) Flight-test is subject to many sources of potential error, e.g. instrumentation errors and atmospheric disturbance during data collection;

(b) Data that exhibit rapid variation or noise may also be difficult to match;

(c) Engineering simulator data and other calculated data may exhibit errors due to a variety of potential differences discussed below.

1.3 When applying tolerances to any test, good engineering judgement should be applied. Where a test clearly falls outside the prescribed tolerance(s) for no apparent reasons, then it should be judged to have failed.

1.4 The use of non-flight-test data as reference data was in the past quite small, and thus these tolerances were used for all tests. The inclusion of this type of data as a validation source has rapidly expanded, and will probably continue to expand.

1.5 When engineering simulator data are used, the basis for their use is that the reference data are produced using the same simulation models as used in the equivalent flight training simulator; i.e., the two sets of results should be 'essentially' similar. The use of flight-test based tolerances may undermine the basis for using engineering simulator data, because an essential match is needed to demonstrate proper implementation of the data package.

1.6 There are, of course, reasons why the results from the two sources can be expected to differ:

(a) Hardware (avionics units and flight controls);

(b) Iteration rates;

(c) Execution order;

(d) Integration methods;

(e) Processor architecture;

(f) Digital drift:

(1) Interpolation methods;

(2) Data handling differences;

(3) Auto-test trim tolerances, etc.

1.7 Any differences should, however, be small and the reasons for any differences, other than those listed above, should be clearly explained.

1.8 Historically, engineering simulation data were used only to demonstrate compliance with certain extra modelling features:

(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.

1.9 The current rapid increase in the use and projected use of engineering simulation data is an important issue because:

(a) Flight-test data are often not available due to sound technical reasons;

(b) Alternative technical solutions are being advanced;

(c) Cost is an ever-present issue.

1.10 Guidelines are therefore needed for the application of tolerances to engineering-simulator-generated validation data.

Non-Flight-Test Tolerances

2.1 Where engineering simulator data or other non-flight-test data are used as an allowable form of reference validation data for the objective tests listed in the table of validation tests, the match obtained between the reference data and the flight simulator results should be very close. It is not possible to define a precise set of tolerances as the reasons for other than an exact match will vary depending upon a number of factors discussed in paragraph one of this appendix.

2.2 As guidance, unless a rationale justifies a significant variation between the reference data and the flight simulator results, 20% of the corresponding ‘flight-test’ tolerances would be appropriate.

2.3 For this guideline (20% of flight-test tolerances) to be applicable, the data provider should supply a well-documented mathematical model and testing procedure that enables an exact replication of their engineering simulation results.

Appendix 2 to AC No.1 to YCAR-STD 1A.030
Validation Data Roadmap

1 General

1.1 Aeroplane manufacturers or other sources of data should supply a validation data roadmap (VDR) document as part of the data package. A VDR document contains guidance material from the aeroplane validation data supplier recommending the best possible sources of data to be used as validation data in the QTG. A VDR is of special value in the cases of requests for 'interim' qualification, requests for qualification of simulations of aeroplanes certificated prior to 1992, and for qualification of alternate engine or avionics fits (see Appendices 3 and 4 of this AC). A VDR should be submitted to the authority as early as possible in the planning stages for any flight simulator planned for qualification to the standards contained herein. The respective State civil aviation authority is the final authority to approve the data to be used as validation material for the QTG. The United States Federal Aviation Administration's National Simulator Program Manager and the Joint Aviation Authorities' Synthetic Training Devices Advisory Board have committed to maintain a list of agreed VDR's.

1.2 The validation data roadmap should clearly identify (in matrix format) sources of data for all required tests. It should also provide guidance regarding the validity of these data for a specific engine type and thrust rating configuration and the revision levels of all avionics affecting aeroplane handling qualities and performance. The document should include rationale or explanation in cases where data or parameters are missing, engineering simulation data are 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 should make reference to other appropriate sources of validation data (e.g., sound and vibration data documents).

1.3 Table 1, below, depicts a generic roadmap matrix identifying sources of validation data for an abbreviated list of tests. A complete matrix should address all test conditions.

1.4 Additionally, two examples of 'rationale pages' are presented in Appendix F of the IATA Flight Simulator Design & Performance Data Requirements document. These illustrate the type of aeroplane and avionics configuration information and descriptive engineering rationale used to describe data anomalies, provide alternative data, or provide an acceptable basis to the authority for obtaining deviations from QTG validation requirements.

ICAO or IATA #	Test Description	CCA Mode*1	Validation Source: Aircraft Flight Test Data *2	Validation Source: Engineering Simulator Data (DEF-73 Engines)	Validation Document: Aerodynamics POM Doc. # xxx123, Rev. A	Validation Document: Flight Controls POM Doc. # xxx456, NEW	Validation Document: Ground Handling POM Doc. # xxx789, Rev. B	Validation Document: Propulsion POM Doc. # xxx321, Rev. C	Validation Document: Integrated POM Doc. # xxx654, Rev. A	Validation Document: Appendix to this VDR Doc. # xxx987, NEW	Comments
	Notes: 1. Only one page is shown; and some test conditions were deleted for brevity; 2. Relevant regulatory material should be consulted and all applicable tests addressed; 3. Validation source, document and comments provided herein are for reference only and do not constitute approval for use										D71 = Engine Type: DEF-71, Thrust Rating: 71.5K D73 = Engine Type: DEF-73, Thrust Rating: 73K **BOLD** upper case denotes primary validation source Lower case denotes alternate validation source R = Rationale included in the VDR Appendix
1.a.1	Minimum Radius Turn		**X**				**D71**				
1.a.2	Rate of Turn vs. Nosewheel Angle (2 speeds)		**X**				**D71**				
1.b.1	Ground Acceleration Time and Distance		**X**				d73		**D73**		Primary data contained in IPOM
1.b.2	Minimum Control Speed, Ground (Vmcg)		x	**X**	d71					**D73**	See engineering rationale for test data in VDR
1.b.3	Minimum Unstick Speed (Vmu)		**X**		**D71**						
1.b.4	Normal Takeoff		**X**		d73				**D73**		Primary data contained in IPOM
1.b.5	Critical Engine Failure on Takeoff		**X**		d71					**D73**	Alternate engine thrust rating flight test data in VDR
1.b.6	Crosswind Takeoff		**X**		d71					**D73**	Alternate engine thrust rating flight test data in VDR
1.b.7	Rejected Takeoff		**X**		**D71**					R	Test procedure anomaly; see rationale
1.b.8	Dynamic Engine Failure After Takeoff			**X**						**D73**	No flight test data available; see rationale
1.c.1	Normal Climb - All Engine		**X**		d71				**D71**		Primary data contained in IPOM
1.c.2	Climb - Engine-Out, Second Segment		**X**		d71					**D73**	Alternate engine thrust rating flight test data in VDR
1.c.3	Climb - Engine-Out, Enroute		**X**		d71					**D73**	AFM data available (73K)
1.c.4	Engine-Out Approach Climb		**X**		**D71**						
1.c.5.a	Level Flight Acceleration		x	**X**	d73					**D73**	Eng sim data w/ modified EEC accel rate in VDR
1.c.5.b	Level Flight Deceleration		x	**X**	d73					**D73**	Eng sim data w/ modified EEC decel rate in VDR
1.d.1	Cruise Performance		**X**		**D71**						
1.e.1.a	Stopping Time & Distance (Wheel Brakes / Light weight)			**X**	**D71**					d73	No flight test data available; see rationale
1.e.1.b	Stopping Time & Distance (Wheel Brakes / Med weight)		**X**	x	**D71**					d73	
1.e.1.c	Stopping Time & Distance (Wheel Brakes / Heavy weight)		**X**	x	**D71**					d73	
1.e.2.a	Stopping Time & Distance (Reverse Thrust / Light weight)		**X**	x	**D71**					d73	
1.e.2.b	Stopping Time & Distance (Reverse Thrust / Med weight)			**X**	d71					**D73**	No flight test data available; see rationale

*[1] CCA mode shall be described for each test condition.

*[2] If more than one aircraft type (e.g., derivative and baseline) are used as validation data more columns may be necessary.

Table 1: Validation Data sRoadmap

Appendix 3 to AC No.1 to YCAR-STD 1A.030
Data Requirements for Alternate Engines - Approval Guidelines

1 Background

1.1 For a new aeroplane type, the majority of flight validation data are collected on the first aeroplane configuration with a 'baseline' engine type. These data are then used to validate all flight simulators representing that aeroplane type.

1.2 In the case of flight simulators representing an aeroplane with engines of a different type than the baseline, or a different thrust rating than that of previously validated configurations, additional flight test validation data may be needed.

1.3 When a flight simulator with additional and/or alternate engine fits is to be qualified, the QTG should contain tests against flight test validation data for selected cases where engine differences are expected to be significant.

2 Approval Guidelines for validating alternate Engine Fits

2.1 The following guidelines apply to flight simulators representing aeroplanes with an alternate engine fit; or, with more than one engine type or thrust rating.

2.2 Validation tests can be segmented into those that are dependent on engine type or thrust rating and those that are not.

2.3 For tests that are independent of engine type or thrust rating, the QTG can be based on validation data from any engine fit. Tests in this category should be clearly identified.

2.4 For tests which are affected by engine type, the QTG should contain selected engine-specific flight test data sufficient to validate that particular aeroplane-engine configuration. These effects may be due to engine dynamic characteristics, thrust levels and/or engine-related aeroplane configuration changes. This category is primarily characterised by differences between different engine manufacturers' products, but also includes differences due to significant engine design changes from a previously flight-validated configuration within a single engine type. See Table 1 below for a list of acceptable tests.

2.5 For those cases where the engine type is the same, but the thrust rating exceeds that of a previously flight-validated configuration by five percent (5%) or more, or is significantly less than the lowest previously validated rating (a decrease of fifteen percent (15%) or more), the QTG should contain selected engine-specific flight test data sufficient to validate the alternate thrust level. See Table 1 below for a list of acceptable tests. However, if an aeroplane manufacturer, qualified as a validation data supplier under the guidelines of Attachment B, shows that a thrust increase greater than 5% will not significantly change the aeroplane's flight characteristics, then flight validation data are not needed.

2.6 No additional flight test data are required for thrust ratings which are not significantly different from that of the baseline or other applicable flight-validated engine-airframe configuration (i.e., less than 5% above or 15% below), except as noted in paragraphs 2.7 and 2.8, below. As an example, for a configuration validated with 50 000 pound-thrust-rated engines, no additional flight validation data are required for ratings between 42 500 and 52 500 lbs. If multiple engine ratings are tested concurrently, only test data for the highest rating are needed.

2.7 Throttle calibration data (i.e., commanded power setting parameter versus throttle position) should be provided to validate all alternate engine types, and engine thrust ratings which are higher or lower than a previously validated engine. Data from a test aeroplane or engineering test bench are acceptable, provided the correct engine controller (both hardware and software) is used.

2.7.1 The validation data described in paragraphs 2.4 through 2.7 above should be based on flight test data, except as noted in those paragraphs, or where other data are specifically allowed within AC No. 1 to YCAR-STD 1A.030(c)(1). However, if certification of the flight characteristics of the aeroplane with a new thrust rating (regardless of percentage change) does require certification flight testing with a comprehensive stability and control flight instrumentation package, then the conditions in table 1 below should be obtained from flight testing and presented in the QTG. Conversely, flight test data other than throttle calibration as described above are not required if the new thrust rating is certified on the aeroplane without need for a comprehensive stability and control flight instrumentation package.

2.8 As a supplement to the engine-specific flight tests of table 1 below and baseline engine-independent tests, additional engine-specific engineering validation data should be provided in the QTG, as appropriate, to facilitate running the entire QTG with the alternate engine configuration. The specific validation tests to be supported by engineering simulation data should be agreed with the authority well in advance of flight simulator evaluation.

2.10 A matrix or 'roadmap' should be provided with the QTG indicating the appropriate validation data source for each test (see Appendix 2 of this AC).

The following flight test conditions (one per test number) are appropriate and should be sufficient to validate implementation of alternate engine fits in a flight simulator.

<table>
<tr><th>TEST NUMBER</th><th colspan="2">TEST DESCRIPTION</th><th>ALTERNATE ENGINE TYPE</th><th>ALTERNATE THRUST RATING [2]</th></tr>
<tr><td>1.b.1, 4</td><td colspan="2">Normal take-off/ground acceleration time & distance</td><td>X</td><td>X</td></tr>
<tr><td>1.b.2</td><td colspan="2">V_{mcg}, if performed for aeroplane certification</td><td>X</td><td>X</td></tr>
<tr><td>1.b.5</td><td>Engine-out take-off</td><td rowspan="2">Either test may be performed.</td><td rowspan="2">X</td><td rowspan="2"></td></tr>
<tr><td>1.b.8</td><td>Dynamic engine failure after take-off</td></tr>
<tr><td>1.b.7</td><td colspan="2">Rejected take-off if performed for aeroplane certification</td><td>X</td><td></td></tr>
<tr><td>1.d.1</td><td colspan="2">Cruise performance</td><td>X</td><td></td></tr>
<tr><td>1.f.1, 2</td><td colspan="2">Engine acceleration and deceleration</td><td>X</td><td>X</td></tr>
<tr><td>2.a.7</td><td colspan="2">Throttle calibration [1]</td><td>X</td><td>X</td></tr>
<tr><td>2.c.1</td><td colspan="2">Power change dynamics (acceleration)</td><td>X</td><td>X</td></tr>
<tr><td>2.d.1</td><td colspan="2">V_{mca} if performed for aeroplane certification</td><td>X</td><td>X</td></tr>
<tr><td>2.d.5</td><td colspan="2">Engine inoperative trim</td><td>X</td><td>X</td></tr>
<tr><td>2.e.1</td><td colspan="2">Normal landing</td><td>X</td><td></td></tr>
</table>

[1] should be provided for all changes in engine type or thrust rating (see paragraph 2.7, above).
[2] See paragraphs 2.5 through 2.8 above for a definition of applicable thrust ratings.

Table 1: Alternate Engine Validation Flight Tests

Appendix 4 to AC No.1 to YCAR-STD 1A.030
Data Requirements for Alternate Avionics (Flight-related Computers & Controllers) – Approval Guidelines

1 Background

1.1 For a new aeroplane type, the majority of flight validation data are collected on the first aeroplane configuration with a 'baseline' flight-related avionics ship-set (see paragraph 2.2, below). These data are then used to validate all flight simulators representing that aeroplane type.

1.2 In the case of flight simulators representing an aeroplane with avionics of a different hardware design than the baseline, or a different software revision than that of previously validated configurations, additional validation data may be required.

1.3 When a flight simulator with additional and/or alternate avionics configurations is to be qualified, the QTG should contain tests against validation data for selected cases where avionics differences are expected to be significant.

2 Approval Guidelines for Validating Alternate Avionics

2.1 The following guidelines apply to flight simulators representing aeroplanes with a revised, or more than one, avionics configuration.

2.2 The aeroplane avionics can be segmented into those systems or components that can significantly affect the QTG results and those that cannot. The following avionics 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 and controllers for engines, autopilot, braking system, nose wheel steering system, high lift system, and landing gear system. Related avionics such as stall warning and augmentation systems should also be considered. The aeroplane manufacturer should identify for each validation test, which avionics systems, if changed, could affect test results.

2.3 The baseline validation data should be based on flight test data, except where other data are specifically allowed (see AC No.1 and 2 to YCAR-STD 1A.030(c)(1)).

2.4 For changes to an avionics system or component that cannot affect MQTG validation test results, the QTG test can be based on validation data from the previously validated avionics configuration.

2.5 For changes to an avionics system or component that could affect an QTG validation test, but where that test is not affected by this particular change (e.g., the avionics change is a BITE update or a modification in a different flight phase), the QTG test can be based on validation data from the previously-validated avionics configuration. The aeroplane manufacturer should clearly state that this avionics change does not affect the test.

2.6 For an avionics change which affects some tests in the QTG, but where no new functionality is added and the impact of the avionics change on aeroplane 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 aeroplane manufacturer's engineering simulation, generated with the revised avionics configuration. In such cases, the aeroplane manufacturer should provide a rationale explaining the nature of the change and its effect on the aeroplane response.

2.7 For an avionics change that significantly affects some tests in the QTG, especially where new functionality is added, the QTG should be based on validation data from the previously-validated avionics configuration and supplemental avionics-specific flight test data sufficient 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. The aeroplane manufacturer should co-ordinate flight simulator data requirements in this situation, in advance, with the authority.

2.8 A matrix or 'roadmap' should be provided with the QTG indicating the appropriate validation data source for each test (see Appendix 2 of AC STD 1A.030).

Appendix 5 to AC No.1 to YCAR-STD 1A.030
Transport Delay Testing Method

1 General

1.1 The purpose of this appendix is to demonstrate how to determine the introduced transport delay through the flight simulator system such that it does not exceed a specific time delay. That is, measure the transport delay 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 show that it is no more than 150 msec.

1.2 Four specific examples of transport delay are described as follows:

(a) simulation of classic non-computer controlled aeroplanes;

(b) simulation of computer controlled aeroplanes using real aeroplane black boxes;

(c) simulation of computer controlled aeroplanes using software emulation of aeroplane boxes;

(d) simulation using software avionics or re-hosted instruments.

1.3 Figure 1 illustrates the total transport delay for a non-computer-controlled aeroplane, or the classic transport delay test.

1.4 Since there are no aeroplane-induced delays for this case, the total transport delay is equivalent to the introduced delay.

1.5 Figure 2 illustrates the transport delay testing method employed on a flight simulator that uses the real aeroplane controller system.

1.6 To obtain the induced transport delay for the motion, instrument and visual signal, the delay induced by the aeroplane controller should be subtracted from the total transport delay. This difference represents the introduced delay and should not exceed 150 msec.

1.7 Introduced transport delay is measured from the cockpit control input to the reaction of the instruments, and motion and visual systems (See figure 1).

1.8 Alternatively, the control input may be introduced after the aeroplane controller system and the introduced transport delay measured directly from the control input to the reaction of the instruments, and simulator motion and visual systems (See figure 2).

1.9 Figure 3 illustrates the transport delay testing method employed on a flight simulator that uses a software emulated aeroplane controller system.

1.10 By using the simulated aeroplane controller system architecture for the pitch, roll and yaw axes, it is not possible to measure simply the introduced transport delay. Therefore, the signal should be measured directly from the pilot controller. Since in the real aeroplane the controller system has an inherent delay as provided by the aeroplane manufacturer, the flight simulator manufacturer should measure the total transport delay and subtract the inherent delay of the actual aeroplane components and ensure that the introduced delay does not exceed 150 msec.

1.11 Special measurements for instrument signals for flight simulators using a real aeroplane instrument display system, versus a simulated or re-hosted display. For the case of the flight instrument systems, the total transport delay should be measured, and the inherent delay of the actual aeroplane components subtracted to ensure that the introduced delay does not exceed 150 msec.

1.11.1 Figure 4A illustrates the transport delay procedure without the simulation of aeroplane displays. The introduced delay consists of the delay between the control movement and the instrument change on the data bus.

1.11.2 Figure 4B illustrates the modified testing method required to correctly measure introduced delay

due to software avionics or re-hosted instruments. The total simulated instrument transport delay is measured and the aeroplane delay should be subtracted from this total. This difference represents the introduced delay and shall not exceed 150 msec. The inherent delay of the aeroplane between the data bus and the displays is indicated as XX msec (See figure 4A). The display manufacturer shall provide this delay time.

1.12 Recorded signals. The signals recorded to conduct the transport delay calculations should be explained on a schematic block diagram. The flight simulator manufacturer should also provide an explanation of why each signal was selected and how they relate to the above descriptions.

1.13 Interpretation of results. It is normal that flight simulator results vary over time from test to test. This can easily be explained by a simple factor called 'sampling uncertainty.' All flight simulators 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 these data will not be processed before the start of the new iteration. For a flight simulator running at 60 Hz a worst-case difference of 16·67 msec can be expected. Moreover, in some conditions, the host simulator 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.

1.14 The transport delay test should account for both daylight and night modes of operation of the visual system. In both cases, the tolerance is 150 msec and motion response shall occur before the end of the first video scan containing new information

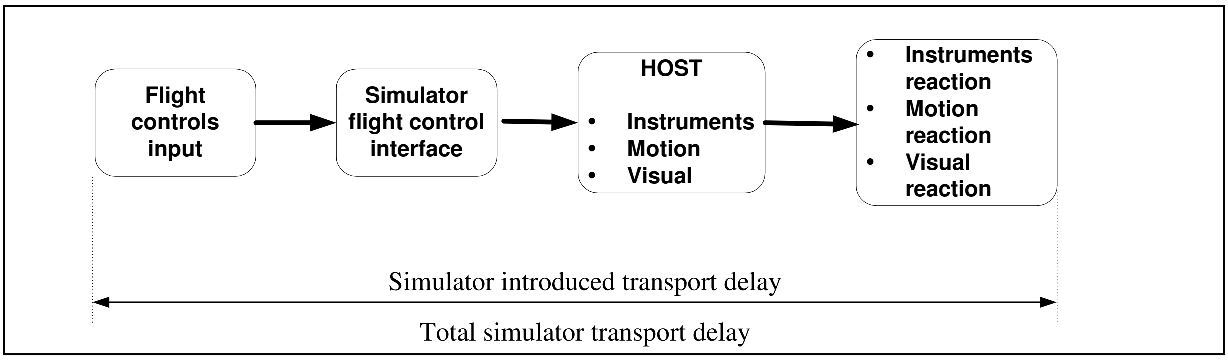

Figure 1: Transport Delay for simulation of classic non-computer controlled aeroplanes

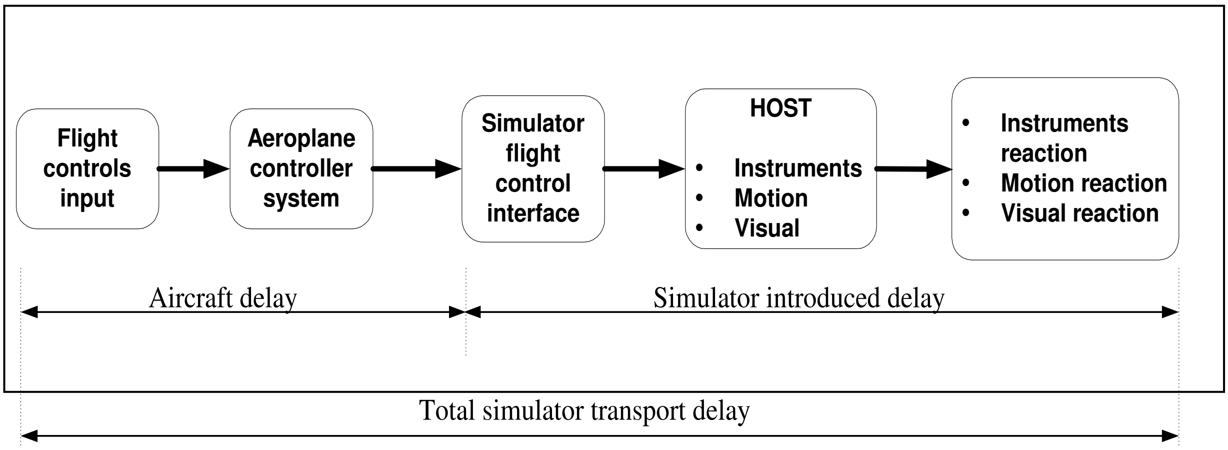

Figure 2: Transport Delay for simulation of computer controlled aeroplanes using real aeroplane black boxes

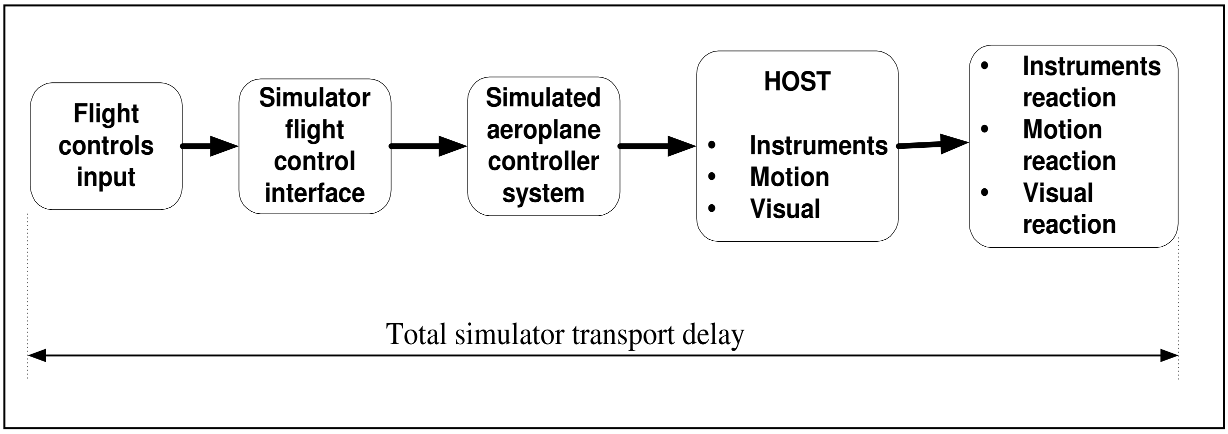

Figure 3: Transport Delay for simulation of computer controlled aeroplanes using software emulation of aeroplane boxes

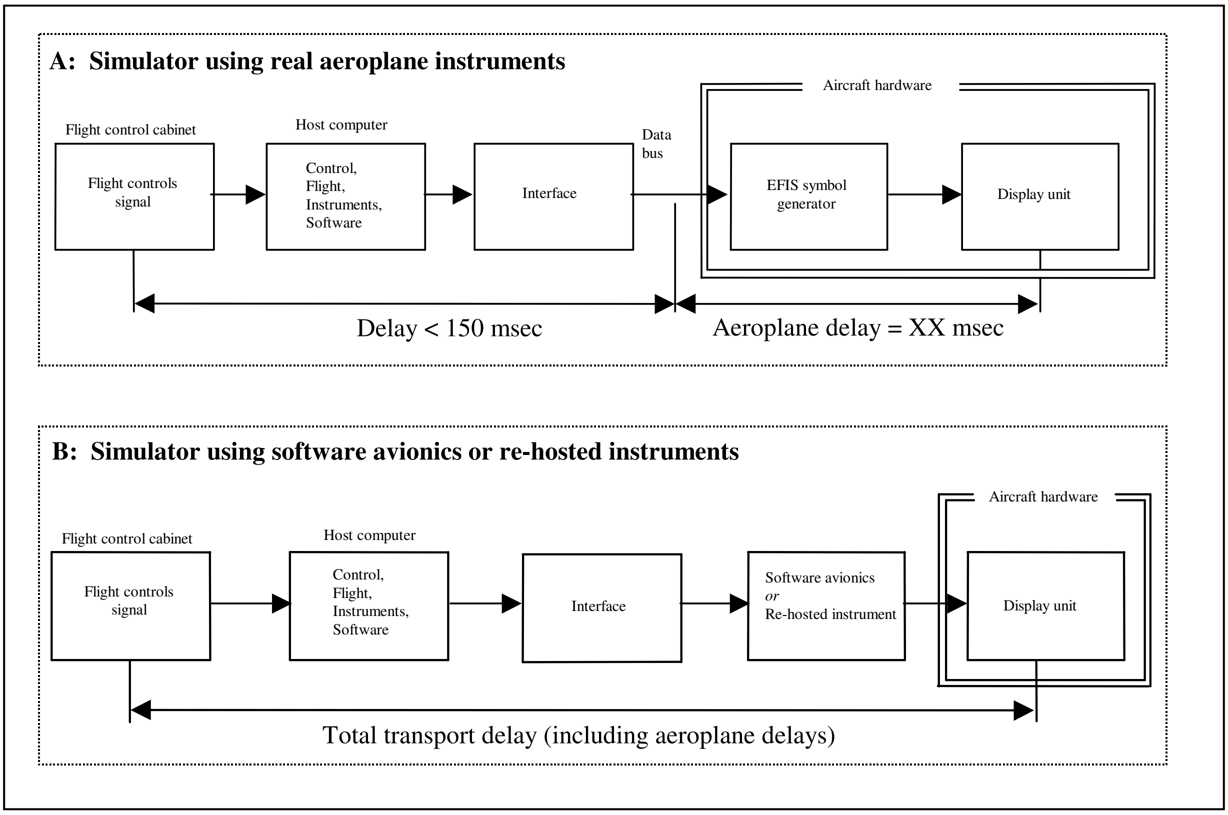

Figure 4A and 4B: Transport delay for simulation of aeroplanes using real or re-hosted instrument drivers

Appendix 6 to AC No.1 to YCAR-STD 1A.030
Recurrent Evaluations - Validation Test Data Presentation

1 Background

1.1 During the initial evaluation of a flight simulator the MQTG is created. This is the master document, as amended, to which flight simulator recurrent evaluation test results are compared.

1.2 The currently accepted method of presenting recurrent evaluation test results is to provide flight simulator results over-plotted with reference data. Test results are carefully reviewed to determine if the test is within the specified tolerances. This can be a time consuming process, particularly when reference data exhibits rapid variations or an apparent anomaly requiring engineering judgement in the application of the tolerances. In these cases the solution is to compare the results to the MQTG. If the recurrent results are the same as those in the MQTG, the test is accepted. Both the flight simulator operator and the authority are looking for any change in the flight simulator performance since initial qualification.

2 Recurrent Evaluation Test Results Presentation

2.1 To promote a more efficient recurrent evaluation, flight simulator operators are encouraged to over-plot recurrent validation test results with MQTG flight simulator results recorded during the initial evaluation and as amended. Any change in a validation test will be readily apparent. In addition to plotting recurrent validation test and MQTG results, operators may elect to plot reference data as well.

2.2 There are no suggested tolerances between flight simulator recurrent and MQTG validation test results. Investigation of any discrepancy between the MQTG and recurrent flight simulator performance is left to the discretion of the flight simulator operator and the authority.

2.3 Differences between the two sets of results, other than minor variations attributable to repeatability issues (see Appendix 1 of this AC), which cannot easily be explained, may require investigation.

2.4 The flight simulator should still retain the capability to over-plot both automatic and manual validation test results with reference data.

AC No. 2 to YCAR-STD 1A.030 (interpretative material)
Level 'A' Flight Simulators
(See YCAR–STD 1A.030)

1 Background

1.2 When determining the cost effectiveness of any flight simulator many factors should be taken into account such as environmental, safety, accuracy, repeatability, quality and depth of training, weather and crowded airspace.

1.3 Although YCAR–STD 1A recognises the criteria for Level 'A' flight simulators described in FAA AC 120–40B, the requirements as laid down by the various regulatory bodies for the lowest level of flight simulator do not appear to have been promoting the anticipated interest in the acquisition of lower cost flight simulator for the smaller aeroplanes used by the general aviation community.

1.4 The significant cost drivers associated with the production of any simulator are:

(a) Type specific data package,

(b) QTG flight test data,

(c) Motion system,

(d) Visual system,

(e) Flight controls and

(f) Aircraft parts.

2 Data package

2.1 The cost of collecting specific flight test data sufficient to provide a complete model of the aerodynamics, engines and flight controls can be significant. The use of a class specific data package which could be tailored to represent a specific type of aeroplane (e.g. PA34 to PA31) is encouraged. This may enable a well engineered light twin baseline data package to be carefully tuned to adequately represent any one of a range of similar aeroplanes. Such work including justification and the rationale for the changes would have to be carefully documented and made available for consideration by the Authority as part of the qualification process. Note that for this lower level of flight simulator, the use of generic ground handling and generic ground effect models is allowed.

2.2 However specific flight test data to meet the needs of each relevant test within the QTG will be required. Recognising the cost of gathering such data, two points should be borne in mind:

(a) For this class of flight simulator, much of the flight test information could be gathered by simple means e.g. stopwatch, pencil and paper or video. However comprehensive details of test methods and initial conditions should be presented.

(b) A number of tests within the QTG have had their tolerances reduced to 'Correct Trend and Magnitude' (CT&M) thereby avoiding the need for specific flight test data.

(c) The use of CT&M is not to be taken as an indication that certain areas of simulation can be ignored. Indeed in the class of aeroplane envisaged, that might take advantage of Level A, it is imperative that the specific characteristics are present, and incorrect effects would be unacceptable (e.g. if the aeroplane has a weak positive spiral stability, it would not be acceptable for the flight simulator to exhibit neutral or negative spiral stability).

d. Where CT&M is used as a tolerance, it is strongly recommended that an automatic recording system be used to 'footprint' the baseline results thereby avoiding the effects of possible divergent subjective opinions on recurrent evaluations.

3 Motion

3.1 For Level A flight simulators, the requirements for both the primary cueing and buffet simulation have been not specified in detail. Traditionally, for primary cueing, emphasis has been laid on the numbers of axes available on the motion system. For this level of flight simulator, it is felt appropriate that the flight simulator

manufacturer should be allowed to decide on the complexity of the motion system. However, during the evaluation, the motion system will be assessed subjectively to ensure that it is supporting the piloting task, including engine failures, and is, under no circumstances, providing negative cueing.

3.2 Buffet simulation is important to add realism to the overall simulation; for Level A, the effects can be simple but they should be appropriate, in harmony with the sound cues and, under no circumstances, provide negative training.

4 Visual

4.1 Other than field of view (FOV), specific technical criteria for the visual systems are not specified. The emergence of lower cost 'raster only' daylight systems is recognised. The adequacy of the performance of the visual system will be determined by its ability to support the flying tasks. e.g. 'visual cueing sufficient to support changes in approach path by using runway perspective'.

4.2 The need for collimated visual optics may not always be necessary. A single channel direct viewing system would be acceptable for a flight simulator of a single crew aeroplane. (The risk here is that, should the aeroplane be subsequently upgraded to multi-crew, the non-collimated visual system may be unacceptable.)

4.3 The vertical FOV specified (30°) may be insufficient for certain tasks. Some smaller aeroplane have large downward viewing angles which cannot be accommodated by the +/–15° vertical FOV. This can lead to two limitations:

(a) At the CAT I all weather operations Decision Height, the appropriate visual ground segment may not be 'seen'; and

(b) During an approach, where the aeroplane goes below the ideal approach path, during the subsequent pitch-up to recover, adequate visual reference to make a landing on the runway may be lost.

5 Flight Controls

The specific requirements for flight controls remain unchanged. Because the handling qualities of smaller aeroplanes are inextricably intertwined with their flight controls, there is little scope for relaxation of the tests and tolerances. It could be argued that with reversible control systems that the on the ground static sweep should in fact be replaced by more representative 'in air' testing. It is hoped that lower cost control loading systems would be adequate to fulfil the needs of this level of simulation (i.e. electric).

6 Aeroplane Parts

As with any level of flight simulator, the components used within the flight deck area need not be aeroplane parts; however, any parts used should be robust enough to endure the training tasks. Moreover, the Level A flight simulator, is type specific, thus all relevant switches, instruments, controls etc. within the simulated area will be required to look and feel 'as aeroplane'.

AC No. 1 to YCAR-STD 1A.030(c)(1) (acceptable means of compliance)
Engineering Simulator Validation Data
See YCAR-STD 1A.030(c)(1)

1. When a fully flight-test validation simulation is modified as a result of changes to the simulated aeroplane configuration, a qualified aeroplane manufacturer may choose, with the prior agreement of the Authority, to supply validation data from an "audited" engineering simulator/simulation to supplement selectively flight test data.

This arrangement is confined to changes which are incremental in nature and which are both easily understood and well-defined.

2. To be qualified to supply engineering simulator validation data, an aeroplane manufacturer should:

(a) have a proven track record of developing successful data packages:

(b) have demonstrated high quality prediction methods through comparisons of predicted and flight test validated data;

(c) have an engineering simulator which

- has models which run in an integrated manner,
- uses the same models as released to the training community (which are also used to produce stand/alone proof-of-match and checkout documents),
- is used to support aeroplane development and certification;

(d) use the engineering simulation to produce a representative set of integrated proof-of-match cases;

(e) have an acceptable configuration control system in place covering the engineering simulator and all other relevant engineering simulations.

3. Aeroplane manufacturers seeking to take advantage of this alternative arrangement shall contact the Authority at the earliest opportunity.

4. For the initial application, each applicant should demonstrate his ability to qualify to the satisfaction of the Authority, in accordance with the criteria in this AC and the corresponding AC No. 2 to YCAR-STD 1A.030(c)(1).

AC No. 2 to YCAR-STD 1A.030(c)(1) (interpretative material)
Engineering Simulator Validation Data – Approval Guidelines
See YCAR-STD 1A.030(c)(1)

1. Background

1.1. In the case of fully flight-test validated simulation models of a new or major derivative aeroplane, it is likely that these models will become progressively unrepresentative as the aeroplane configuration is revised.

1.2. Traditionally as the aeroplane 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.

1.3. 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.

1.4. The major aeroplane 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 aeroplane hardware to non-real-time work station based simulations.

2. Approval Guidelines – for using Engineering Simulator Validation Data

2.1. The current system of requiring flight test data as a reference for validating training simulators should continue.

2.2. When a fully flight-test-validated simulation is modified as a result of changes to the simulated aeroplane configuration, a qualified aeroplane manufacturer may choose, with prior agreement of the Authority, to supply validation data from an engineering simulator/simulation to supplement selectively flight test data.

2.3. In cases where data from an engineering simulator is used, the engineering simulation process would have to be audited by the Authority.

2.4 In all cases a data package verified to current standards against flight test should be developed for the aeroplane "entry-into-service" configuration of the baseline aeroplane.

2.5 Where engineering simulator data is used as part of a QTG, an essential match is expected as described in Appendix 2 to YCAR-STD 1A.030.

2.6 In cases where the use of engineering simulator data is envisaged, a complete proposal should be presented to the appropriate regulatory body(ies). Such a proposal would contain evidence of the aeroplane manufacturer's past achievements in high fidelity modelling.

2.7 The process will be applicable to "one step" away from a fully flight validated simulation.

2.8 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 validated) version.

2.9 The Authorities will conduct technical reviews of the proposed plan and the subsequent validation data to establish acceptability of the proposal.

2.10 The procedure will be considered complete when an approval statement is issued. This statement will identify acceptable validation data sources.

2.11 To be admissible as an alternative source of validation data an engineering simulator would:

(a) Have to exist as a physical entity, complete with a flight deck representative of the affected class of aeroplane, with controls sufficient for manual flight.

(b) Have a visual system; and preferably also a motion system.

(c) Where appropriate, have actual avionics boxes interchangeable with the equivalent software simulations, to support validation of released software.

(d) Have a rigorous configuration control system covering hardware and software.

(e) Have been found to be a high fidelity representation of the aeroplane by the pilots of the manufacturers, operators and the Authority.

2.12 The precise procedure followed to gain acceptance of engineering simulator data will vary from case-to-case between aeroplane manufacturers and type of change. Irrespective of the solution proposed, engineering simulations/simulators should conform to the following criteria:

(a) The original (baseline) simulation models should have been fully flight-test validated.

(b) The models as released by the aeroplane manufacturer to the industry for use in training Flight Simulators should be essentially identical to those used by the aeroplane manufacturer in their engineering simulations/simulators.

(c) These engineering simulation/simulators will have been used as part of the aeroplane design, development and certification process.

2.13 Training flight simulator(s) utilising these baseline simulation models should be currently qualified to at least internationally recognised standards such as contained in the ICAO Document 9625, the "Manual of Criteria for the Qualification of Flight Simulators".

2.14 The type of modifications covered by this alternative procedure will be restricted to those with "well understood effects":

(a) Software (e.g., flight control computer, autopilot, etc.).

(b) Simple (in aerodynamic terms) geometric revisions (e.g., body length).

(c) Engines – limited to non-propeller-driven aeroplanes.

(d) Control system gearing/rigging/deflection limits

(e) Brake, tyre and steering revisions.

2.15 The manufacturer, who wishes to take advantage of this alternative procedure, is expected to demonstrate a sound engineering basis for his proposed approach. Such analysis would 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 were not required. In the event that the predicted effects were not deemed to be sufficiently accurate, it might be necessary to collect a limited set of flight test data to validate the predicted increments.

2.16 Any applications for this procedure will be reviewed by an Authorities team established by the Authority.

AC STD 1A.035
Flight Simulators Approved or Qualified before 1 April 1998
See YCAR–STD 1A.035

1 Introduction

1.1 Under previous national rules, flight simulators may have gained credits in accordance with primary reference documents which state appropriate technical criteria.

1.2 Other Flight Simulators may not have been monitored to the same extent, but may have documents or statements from their Authority giving broad or specific permission for them to be used for certain training, testing and checking manoeuvres.

1.3 In any case, it is intended that flight simulators should continue to maintain their Qualification Level and/or approval granted prior to the adoption of YCAR–STD 1A.

2 Re-categorisation

Some of these flight simulators may be of a standard which permits them to be re-categorised as if they were flight simulators presented for initial qualification on or after 1 April 1998.

3 Equivalent categories AG, BG, CG, DG

3.1 Flight simulators that are not and that do have an acceptable primary reference document used for their original national qualification or national approval will gain a qualification based upon their original technical Qualification Level or credits which are equivalent to those described in Appendix 2 to YCAR–STD 1A.030. The equivalent qualification will relate to permitted manoeuvres in the original national qualification/approval document providing that these older flight simulators continue to meet the original national criteria when evaluated by the Authority.

3.2 The letter G will be added to each originally issued Qualification Level to show that the existing Qualification Level deserves its credit under the grandfather right provisions. To comply with the rule, the primary reference document should have meaningful validation, functions and subjective tests criteria which reasonably cover the performance envelope of the flight simulator and in particular the manoeuvres for which the equivalent Qualification Level is given. The minimum acceptable standard is FAA AC 120-40A or equivalent.

4 Original national qualification

4.1 Flight simulators that are not, and that do not have, an acceptable primary reference document may continue to enjoy credits for an agreed list of training, testing and checking manoeuvres, provided they maintain their performance in accordance with any validation, functions and subjective tests which have been previously established or a list of tests selected from AC STD 1A.030 by agreement with the Authority. Again the tests should relate to the list of manoeuvres permitted under the original national qualification/approval document.

4.2 The award of credits to an STD user should be at the discretion of the Authority. Current STD users may retain the credits granted under their previous national criteria.

5 Grandfather rights summary

The following table summarises the arrangements for flight simulators approved or qualified before 1 April 1998 and which are not re-categorised:

Primary Reference Document available	*equivalent qualification level*	*Performance criteria*
Yes	AG Maximum training, BG testing and checking CG Credits similar DG to A, B, C, D	Perform to the original national validation functions and subjective tests from reference doc.
No	Special Categories Unique list of manoeuvres	Original validation, functions and subjective tests or a list of tests selected from AC STD 1A.030 (by agreement)

AC STD 1A.045 (explanatory material)
New Aeroplane Flight Simulator Qualification – Additional Information
See YCAR–STD 1A.045

1 It is usual that aeroplane manufacturer's approved final data for performance, handling qualities, systems or avionics will not be available until well after a new or derivative aeroplane has entered service. It is often necessary to begin flight crew training and certification several months prior to the entry of the first aeroplane into service and consequently it may be necessary to use aeroplane manufacturer-provided preliminary data for interim qualification of flight simulators.

2 In recognition of the sequence of events that should occur and the time required for final data to become available, the Authority may accept certain partially validated preliminary aeroplane and systems data, and early release ('red label') avionics in order to permit the necessary programme schedule for training, certification and service introduction.

3 STD operators seeking qualification based on preliminary data should, however, consult the Authority as soon as it is known that special arrangements will be necessary or as soon as it is clear that the preliminary data will need to be used for flight simulator qualification. Aeroplane and flight simulator manufacturers should also be made aware of the needs and be agreed party to the data plan and flight simulator qualification plan. The plan should include periodic meetings to keep the interested parties informed of project status.

4 The precise procedure to be followed to gain Authority acceptance of preliminary data will vary from case to case and between aeroplane manufacturers. Each aeroplane manufacturer's new aeroplane development and test programme is designed to suit the needs of the particular project and may not contain the same events or sequence of events as another manufacturer's programme or even the same manufacturer's programme for a different aeroplane. Hence, there cannot be a prescribed invariable procedure for acceptance of preliminary data, but instead there should be a statement describing the final sequence of events, data sources, and validation procedures agreed by the STD operator, the aeroplane manufacturer, the flight simulator manufacturer, and the Authority.

NOTE: A description of aeroplane manufacturer-provided data needed for flight simulator modelling and validation is to be found in the IATA Document 'Flight Simulator Design and Performance Data Requirements' – (Edition 6 2000 or as amended).

5 There should be assurance that the preliminary data are the manufacturer's best representation of the aeroplane and reasonable certainty that final data will not deviate to a large degree from these preliminary, but refined, estimates. Data derived from these predictive or preliminary techniques should be validated by available sources including, at least, the following:

(a) Manufacturer's engineering report. Such report will explain the predictive method used and illustrating past success of the method on similar projects. For example, the manufacturer could show the application of the method to an earlier aeroplane model or predict the characteristics of an earlier model and compare the results to final data for that model.

(b) Early flight tests results. Such data will often be derived from aeroplane certification tests, and should be used to maximum advantage for early flight simulator validation. Certain critical tests, which would normally be done early in the aeroplane certification programme, should be included to validate essential pilot training and certification manoeuvres. These include cases in which a pilot is expected to cope with an aeroplane failure mode including engine failures. The early data available will, however, depend on the aeroplane manufacturer's flight test programme design and may not be the same in each case. However it is expected that the flight test programme of the aeroplane manufacturer include provisions for generation of very early flight tests results for flight simulator validation.

6 The use of preliminary data is not indefinite. The aeroplane manufacturer's final data should be available within 6 months after aeroplane first 'service entry' or as agreed by the Authority, the STD operator and the aeroplane manufacturer, but usually not later than 1 year. In applying for an interim qualification, using preliminary data, the STD operator and the Authority should agree upon the update programme. This will normally specify that the final data update will be installed in the flight simulator within a period of 6 months following the final data release unless special conditions exist and a different schedule agreed. The flight simulator performance and handling validation would then be based on data derived from flight test. Initial aeroplane systems data should be updated after engineering tests. Final aeroplane systems data should also be used for flight simulator programming and validation.

7 Flight simulator avionics should stay essentially in step with aeroplane avionics (hardware & software) updates. The permitted time lapse between aeroplane and flight simulator updates is not a fixed time but should be minimal. It may depend on the magnitude of the update and whether the QTG and pilot training and certification is affected. Permitted differences in aeroplane and flight simulator avionics versions and the resulting effects on flight simulator qualification should be agreed between the STD operator and the Authority. Consultation with the flight simulator manufacturer is desirable throughout the agreement of the qualification process.

8 The following describes an example of the design data and sources which might be used in the development of an interim qualification plan.

(a) The plan should consist of the development of a QTG based upon a mix of flight test and engineering simulation data. For data collected from specific aeroplane flight tests or other flights the required designed model/data changes necessary to support an acceptable Proof of Match (POM) should be generated by the aeroplane manufacturer.

(b) In order that the two sets of data are properly validated, the aeroplane manufacturer should compare their simulation model responses against the flight test data, when driven by the same control inputs and subjected to the same atmospheric conditions as were recorded in the flight test. The model responses should result from a simulation where the following systems are run in an integrated fashion and are consistent with the design data released to the flight simulator manufacturer:

(1) propulsion

(2) aerodynamics

(3) mass properties

(4) flight controls

(5) stability augmentation

(6) brakes/landing gear.

9 For the qualification of flight simulators of new aeroplane types, it may be beneficial that the services of a suitably qualified test pilot are used for the purpose of assessing handling qualities and performance evaluation.

NOTE: The Proof of Match should meet the relevant AC No. 1 to YCAR- STD 1A.030 tolerances.