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YCAR-STD 1H

HELICOPTER FLIGHT SIMULATORS

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YCAR-STD 1H

HELICOPTER FLIGHT SIMULATORS

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SUBPART A - APPLICABILITY

YCAR-STD 1H.001 Applicability

YCAR-STD 1H applies to those persons or organisations (STD operators) seeking qualification of Flight Simulators (FS). Flight Simulator Users also shall obtain 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 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 1H.005 Terminology
(See AMC-STD 1H.005)

Because of the technical complexity of Synthetic Training Device (STD) qualification, it is essential that standard terminology is used throughout. The following principle terms and abbreviations shall be used in order to comply with YCAR-STD. Further terms and abbreviations are contained in AMC STD 1H.005.

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

(b) *Flight Simulator (FS)* A full size replica of a specific type or make, model and series helicopter flight deck/cockpit, including the assemblage of all equipment and computer programmes necessary to represent the helicopter in ground and flight operations, a visual system providing an out of the flight deck/cockpit 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 a specific helicopter type's instruments, equipment, panels, and controls in an open flight deck/cockpit area or an enclosed helicopter cockpit/flight deck, including the assemblage of equipment and computer programmes necessary to represent the helicopter 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 a helicopter in flight conditions to the extent that the systems appear to function as in a helicopter. It is in compliance with the minimum standards for a specific FNPT Level of Qualification.

(e) *Synthetic Training Device User Approval (STD User 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 helicopter to STD differences and the operating and training ability of the organisation.

(f) *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.

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

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

(i) *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 helicopter and that all applicable regulatory requirements have been met. The QTG includes both the helicopter and STD data used to support the validation.

SUBPART C - HELICOPTER FLIGHT SIMULATORS

YCAR-STD 1H.015 Application for Flight Simulator Qualification

(See AMC STD 1H.015)

(See IEM STD 1H.015)

(a) The operator of a Flight Simulator requiring evaluation of this simulator shall apply to the Authority giving 3 months notice.

(b) A Flight Simulator Qualification Certificate shall be issued following satisfactory completion of an evaluation by the Authority.

YCAR-STD 1H.020 Validity of Flight Simulator Qualification

(a) A Flight Simulator qualification is valid for 12 months unless otherwise specified by the Authority.

(b) A Flight Simulator qualification test for 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 a Flight Simulator qualification, if the requirements of YCAR-STD 1H are not satisfied.

YCAR-STD 1H.025 Rules governing Flight Simulator Operators

(See AMC STD 1H.025

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

(a) *Quality System*

(1) A Quality System shall be established and a Quality Manager designated who shall monitor compliance with, and the adequacy of, procedures required to ensure the maintenance of the Qualification Level of FS. Compliance monitoring shall include a feed-back 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) Helicopter modifications, whether or not enforced by an airworthiness directive, which are essential for training, testing and checking shall be introduced into all affected Flight Simulators.

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

(i) Where applicable and essential for training, testing and checking, STD operators shall update their Flight Simulators (for example in the light of data revisions). Modifications of the Flight Simulator hardware and software, which affect flight, and 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 Flight Simulator 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 simulator may be necessary prior to returning it to training following the modification.

(c) *Installations.* Ensure that the Flight Simulator is located in a suitable environment, which supports 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 simulator safety to ensure that they are aware of all safety equipment and arrangement in the 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 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 (seat, seat belts...)

(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 pilots and instructor seats.

(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 1H.030 Requirements for Flight Simulators qualified on or after 1 January 2005

(See Appendix to YCAR-STD 1H.030)

(See AMC STD 1H.030)

(See IEM STD 1H.030)

(a) Any Flight Simulator submitted for initial evaluation on or after 1 January 2005, shall be evaluated against YCAR-STD 1H criteria for Qualification Levels A, B, C or D.

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

(1) Longitudinal, lateral and directional handling qualities, and

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

(3) Specific operations where applicable, and

(4) Cockpit configuration, and

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

(6) Instructor station function and simulator control, and

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

(c) The Flight Simulator shall be subjected to:

(1) Validation tests, and

(2) Functions & Subjective tests as found in the Qualification Test Guide (QTG)

(d) Data, which is 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 simulator standards are being maintained and,

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

Appendix 1 to YCAR-STD 1H.030 Minimum Flight Simulator Requirements

(a) This Appendix describes the minimum Flight Simulator requirements for qualifying Level A, B, C and D Flight Simulators.

(1) Each of those four levels carries a technical description and it will show in broad terms the training, testing and checking credits.

(2) The training, checking and testing credits do not imply an automatic Approval for any Flight Simulator User.

(3) Specific requirements for the use of the helicopter or Flight Simulator are determined by the Authority. Specialized training courses require an adequate standard of simulation, which will be evaluated by the Authority.

Note: 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.

Table 1 - Minimum Flight Simulator requirements for qualifying Level A, B, C and D Simulators

Qualification Level	General Technical Requirements	Credits (Reserved until classification by YCAR-OPS and YCAR-FCL)
LEVEL A	(See also IEM STD 1H.030). The lowest level of simulator technical complexity. An enclosed full-scale replica of the helicopter cockpit/flight deck with representative pilots seats, including simulation of all systems, instruments, navigational equipment, communications and caution and warning systems. An Instructor's station with seat shall be provided and at least one additional seat for inspectors/observers. Static control forces and displacement characteristics shall correspond to that of the replicated helicopter and they shall reflect the helicopter under the same static flight conditions. Representative/generic aerodynamic data tailored to the specific helicopter type with fidelity sufficient to meet the Objective Tests may be used. Functions and Subjective Tests are 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. A motion system having a minimum of three degrees of freedom (pitch, roll, and heave) to accomplish the required training tasks shall be provided. The visual system shall provide at least 45 degrees horizontal and 30 degrees vertical field of view per pilot. A night/dusk scene is acceptable. The response to control inputs shall not be greater than 150 milliseconds more than that experienced on the helicopter.	Suitable for: Reserved
LEVEL 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. A reduced six-axis motion performance envelope is acceptable. The visual system shall provide at least 75 degrees horizontal and 40 degrees vertical field of view per pilot.	**As for Level A plus:** Reserved
LEVEL C	The second highest Level of simulator performance. As for Level B plus: A Daylight/Dusk/Night Visual system is required with a continuous field of view per pilot of not less than 150 degrees horizontal and 40 degrees vertical. The sound simulation shall include the sounds of precipitation and significant helicopter 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 100 milliseconds more than that experienced on the helicopter. Turbulence and other atmospheric models shall be provided to support the training, testing and checking credit sought.	**As for Level B plus:** Reserved
LEVEL D	The highest Level of simulator performance. As for Level C plus: A full Daylight/Dusk/Night visual system is required with a continuous field of view per pilot of not less than 180 degrees horizontal and 60 degrees vertical and there shall be complete fidelity of sounds and motion buffets.	**As for Level C plus:** Reserved

YCAR-STD 1H.035 Requirements for Flight Simulators approved or qualified before 1 January 2005

(See AMC STD 1H.035)

(a) Flight Simulators approved or qualified in accordance with national regulations of JAA Members States before 01 January, 2005 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 simulators will be qualified in accordance with YCAR-STD 1H.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 Qualification Level, either AG, BG, CG or DG. These Qualification Levels refer to similar credits achieved by YCAR-STD Levels A, B, C & D.

(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, testing and checking process, including:

(i) Longitudinal, lateral and directional handling qualities, and

(ii) Performance on the surface and in the air, and

(iii) Specific operations where applicable, and

(iv) Cockpit configuration, and

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

(vi) Instructor station function and simulator control, and

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

(2) The Flight Simulator 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 recognized Validation Test shall be used.

YCAR-STD 1H.040 Changes to Qualified Flight Simulators

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

(1) Helicopter modifications which could affect Flight Simulator qualification, and

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

(3) Relocation of the Flight Simulator, and

(4) Any deactivation of the Flight Simulator.

Note: 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 level.

(2) In the case of a Flight Simulator upgrade, a 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 Flight 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 Flight 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 an 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 arrange an understanding with the Authority to ensure that the Flight Simulator can be restored to active status at its original Qualification Level.

YCAR-STD 1H.045 Interim Flight Simulator Qualification

(See AMC STD 1H.045),

(See IEM STD 1H.045)

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

(b) The Authority will decide requirements, details relating to the issue and the period of validity of an interim Qualification Level.

(c) The maximum interim Qualification Level shall be Qualification Level C.

YCAR-STD 1H.050 Transferability of Flight Simulator Qualification

(a) When there is a change of STD operator, the new STD 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.

SECTION 2 – ACCEPTABLE MEANS OF COMPLIANCE (AMC) / INTERPRETATIVE AND EXPLANATORY MATERIAL (IEM)

1 GENERAL

1.1 This Section contains Acceptable Means of Compliance and Interpretative/Explanatory Material that has been agreed for inclusion in YCAR - STD 1H.

1.2 Where a particular paragraph does not have an Acceptable Means of Compliance or any Interpretative/Explanatory Material, it is considered that no supplementary material is required.

2 PRESENTATION

2.1 The Acceptable Means of Compliance and Interpretative and Explanatory Material are presented in full page width on loose pages, each page being identified by the date of issue and/or the Amendment number under which it is amended or reissued.

2.2 A numbering system has been used in which the Acceptable Means of Compliance or Interpretative/Explanatory Material uses the same number as the YCAR paragraph to which it refers. The number is introduced by the letters AMC or IEM to distinguish the material from the YCAR itself.

2.3 The acronyms AMC and IEM also indicate the nature of the material and for this purpose the two types of material are defined as follows:

Acceptable Means of Compliance (AMC) 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 AMC is developed, any such AMC (which may be additional to an existing AMC) will be amended into the document following consultation under the NPA procedure.

Interpretative/Explanatory Material (IEM) helps to illustrate the meaning of a requirement.

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

AMC/IEM B - GENERAL

AMC STD 1H.005 Terminology, Abbreviations
See YCAR-STD 1H.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 (H) have the following meanings:

a. Automatic Testing. Synthetic Training Device (STD) testing wherein all stimuli are under computer control.

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

c. 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.

d. Control Sweep. A movement of the appropriate pilot's control from neutral to an extreme limit in one direction, a continuous movement back through neutral to the opposite extreme position, and then a return to the neutral position.

e. Convertible STD. An STD in which hardware and software can be changed so that the STD becomes a replica of a different model or variant, usually of the same type helicopter. The same STD platform, cockpit shell, motion system, visual system, computers, and necessary peripheral equipment can thus be used in more than one simulation.

f. Critical Engine Parameter. The parameter which is the most appropriate measure of engine power.

g. 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.

h. 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.

i. 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.

j. 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.

k. 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 - it is simply driven to certain predetermined values.

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

m. Free Response. The response of the helicopter after completion of a control input or disturbance.

n. Frozen/Locked. A state where a variable is held constant with time.

o. Functions Test. A quantitative assessment of the operation and performance of an STD by a suitably qualified evaluator. The test can include verification of correct operation of controls, instruments, and systems of the simulated helicopter 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.

p. Grandfather Rights.

i. The right of an STD operator to retain the Qualification Level granted under a previous regulation of an ICAO Member State.

ii. Also the right of an STD user to retain the training and testing/checking credits which were gained under a previous regulation of an ICAO Member State.

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

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

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

t. Highlight Brightness. The maximum displayed brightness which satisfies the brightness test in AMC STD 1H.030 para 2.3.

u. Integrated Testing. Testing of the STD such that all helicopter system models are active and contribute appropriately to the results. None of the helicopter 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.

v. Irreversible Control System. A fully powered control system in which movement of the control surface will not backdrive the pilot's control in the cockpit or affect its feel characteristics.

w. Latency. The additional time, beyond that of the basic perceivable response time of the helicopter due to the response time of the STD.

x. 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.

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

z. 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.

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

bb. Power Lever Angle (PLA). The angle of the pilot's primary engine control lever(s) in the cockpit. This may also be referred to as THROTTLE or POWER LEVER.

cc. Predicted Data. Data derived from sources other than type specific helicopter flight tests.

dd. 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.

ee. Protection Functions. Systems functions designed to protect a helicopter from exceeding its flight and manoeuvre limitations .

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

gg. Reversible Control System. A partially powered or unpowered control system in which movement of the control surface will backdrive the pilot's control in the cockpit and/or affect its feel characteristics.

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

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

jj. STD Data. The various types of data used to design, manufacture, test and maintain the STD.

kk. STD Evaluation. A detailed appraisal of an STD by the Authority to ascertain whether or not the standard required for a specified Qualification Level is met.

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

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

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

oo. Translational Lift (Transverse Flow effect). In forward flight, air passing through the rear portion of the rotor disk has a greater downwash angle than air passing through the forward portion.

pp. Transport Delay. The total STD system processing time required for an input signal from a pilot primary flight control until 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 helicopter simulated.

qq. Upgrade. The improvement or enhancement of an STD for the purpose of achieving a higher qualification.

rr. Validation Data. Data used to prove that the STD performance corresponds to that of the helicopter.

ss. Validation Flight Test Data. Performance, stability and control, and other necessary test parameters electrically or electronically recorded in a helicopter 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 STD parameters can be compared.

tt. Validation Test. A test by which STD parameters can be compared with the relevant Validation Data.

uu. 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.

2. Abbreviations

AC	=	Advisory Circular
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
AWOPS	=	All Weather Operations
Bank	=	Bank/Roll angle (degrees)
cd/m^2	=	candela/metre^2, 3·4263 candela/m^2 = 1 ft-Lambert
cm	=	centimetre, centimetres
daN	=	decaNewtons
deg	=	degree, degrees
distance	=	distance in nautical miles unless specified otherwise
DGPS	=	Differential Global Positioning System
EPR	=	Engine Pressure Ratio
FAA	=	Federal Aviation Administration

FATO	=	Final Approach and Take-off
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
GPS	=	Global Positioning System
Height	=	Height above ground = AGL (metres or feet)
IATA	=	International Air Transport Association
ICAO	=	International Civil Aviation Organisation
IGE	=	In Ground Effect
IOS	=	Instructor Operating Station
IQTG	=	International Qualification Test Guide
km	=	Kilometres; 1 km = 0·53996 Nautical 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
m	=	Metres; 1 metre = 3·28083 feet
MCC	=	Multi-Crew Co-operation
Medium	=	Normal operational weight for flight segment
min	=	Minutes
MLG	=	Main Landing Gear
MPa	=	MegaPascals [1 psi = 6894·76 pascals]
ms	=	millisecond(s)
NM	=	Nautical Mile; 1 Nautical Mile = 6 080 feet = 1852 m
Nominal	=	Normal operational weight, configuration, speed, etc, for the flight segment specified
N1/Ng	=	Gas Generator Speed
N2/Nf	=	Free Turbine Speed
NR	=	Main Rotor Speed
NWA	=	Nosewheel Angle (degrees)
n	=	Sequential period of a full cycle of oscillation
OGE	=	Out of Ground Effect
PAPI	=	Precision Approach Path Indicator System
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
psi	=	Pounds per square inch
QTG	=	Qualification Test Guide
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)
RVR = Runway Visual Range (metres or feet)

s = second(s)
sec(s) = second, seconds
1st Segment = That portion of the take-off profile during a category A profile until reaching Vtoss, 35 feet and positive rate of climb with landing gear extended – with engine failure at TDP and maximum certified power on the remaining engine(s)
2nd Segment = That portion of a take-off profile from gear retraction until reaching 1 000 feet above the take-off surface with engine failure at TDP and the remaining engine(s) at 30 minutes power rating
Sideslip = Sideslip Angle (degrees)
SOC = Statement of Compliance

T(A) = Tolerance applied to Amplitude
TLOF = Touch down and lift-off
T(p) = Tolerance applied to period
T/O = Takeoff
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
VGS = Visual Ground Segment

WAT = Weight, Altitude and Temperature (aircraft take-off factors)

AMC/IEM C – HELICOPTER FLIGHT SIMULATORS

AMC STD 1H.015 Flight Simulator Qualification - Application and Inspection
See IEM-STD 1H.015

1. Letter of Application.

A sample of letter of application is provided overleaf.

LETTER OF APPLICATION FOR INITIAL EVALUATION OF A FLIGHT SIMULATOR

(Date)....................

PRINCIPAL INSPECTOR
(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 Name)......Flight Simulator with its ....(Visual System Manufacturer Name)........Visual System is fully defined on page .... of the accompanying Qualification Test Guide (QTG) which was run on ....(date)......... at ....(place)...... We have completed tests of the Flight Simulator and declare that it meets all applicable requirements of YCAR-STD 1H (Helicopter Flight Simulators) except as noted below. Appropriate hardware and software configuration control procedures have been established and these are appended for your inspection and approval.

The simulator has been assessed by the following evaluation team:

.......................(name)........................Qualification ....

.......................(name)........................Qualification ....

.......................(name)........................Qualification ....

.......................(name)........................Pilot's Licence Nr................

who attest(s) that it conforms to the helicopter cockpit configuration of ....(Name of STD operator)..........(type of helicopter)....... helicopter and that the simulated systems and subsystems function equivalently to those in that helicopter. This pilot has also assessed the performance and the flying qualities of the Flight Simulator and find that it represents the designated helicopter.

(additional comments as required)

The following tests are outstanding:
....
....
....
It is expected that they will be completed and submitted 3 weeks prior to the evaluation date.

Sincerely,

Print Name
Position/Appointment held

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 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 JAA Authority, who is qualified in flight crew training procedures and is holding a valid type rating on the helicopter being simulated; or

(ii) A flight inspector of the Authority who is qualified in flight crew training procedures assisted by a Type Rating Instructor, holding a valid type rating on the helicopter being simulated; or, exceptionally,

(iii) A person designated by the Authority who is qualified in flight crew training procedures and is holding a valid type rating on the helicopter being simulated.

Where a designated person is used as a substitute for one of the Authority's inspectors, the other person must 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 STD users.

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

IEM STD 1H.015 Flight Simulator Evaluations
See YCAR-STD 1H.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 1H.030 and YCAR-STD 1H.035, and detailed in AMC STD 1H.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 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 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.

2.2 Subjective Testing

2.2.1 The Subjective Tests for the evaluation can be found in AMC-STD 1H.030, and a suggested Subjective Test Profile is described in sub-paragraph 4.6 below.

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

2.3 Conclusion

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. Again adequate notification would be given when special equipment is required for the test.

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 simulator cannot be used for Subjective Tests or other functions whilst testing is in progress. For simulators 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 AMC-STD 1H.030.

3.2.2 Normally, the time taken for recurrent Subjective Testing is about four (4) hours, and the simulator cannot perform other functions during this time.

3.3 Conclusion

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 competent authority will conduct a series of Functions and Subjective Tests which together with the Objective Tests complete the comparison of the simulator with the helicopter.

4.2 Whereas Functions Tests verify the acceptability of the simulated helicopter systems and their integration, Subjective Tests verify the fitness of the 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 helicopter environment.

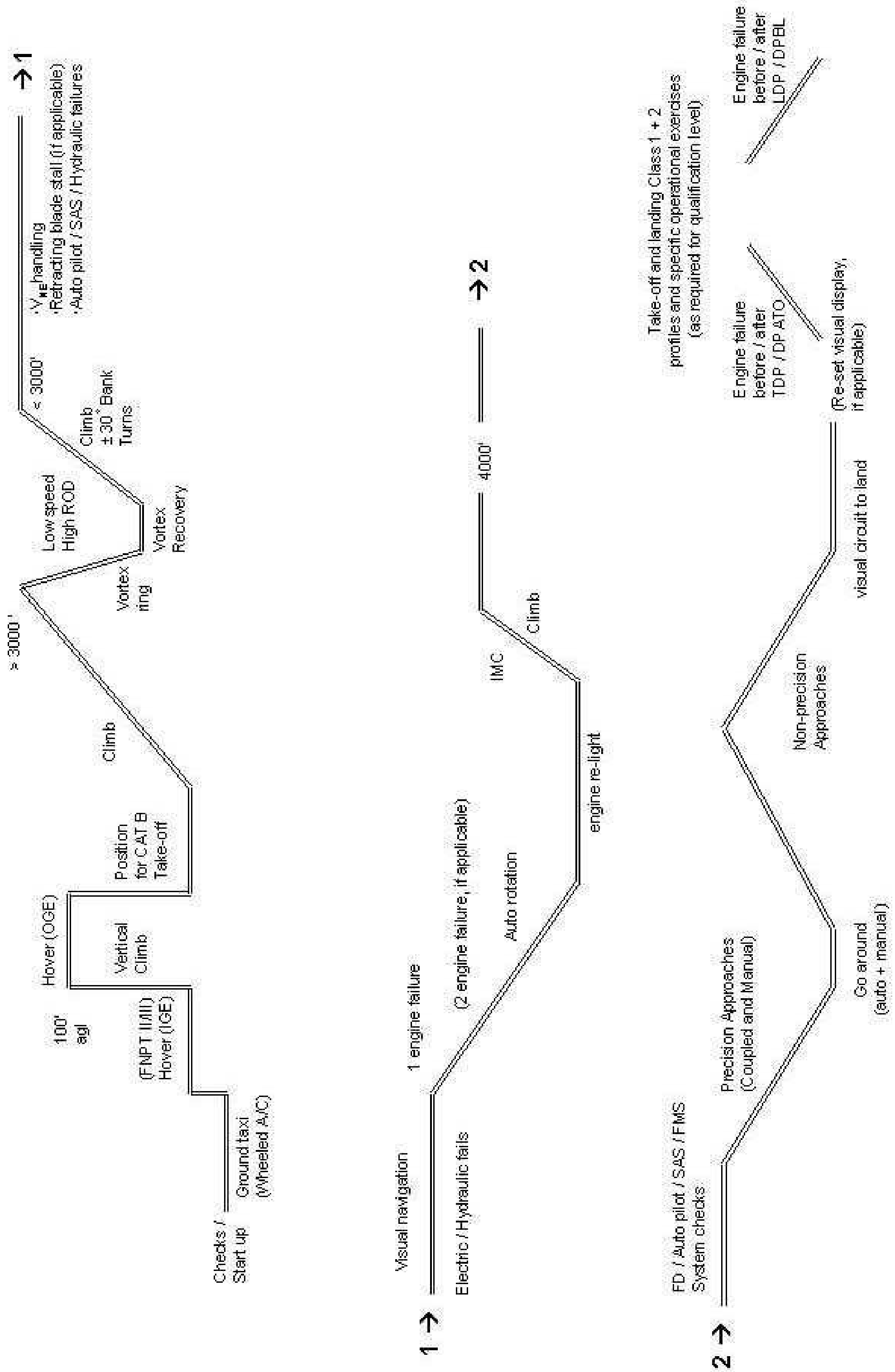
Additionally, the Instructor Operating Station (IOS) should be simple enough to give the instructor spare capacity to observe the activities of the flight crew.

4.4 Section 1 of YCAR-STD 1H sets out the requirements, and the AMC in Section 2 the means of compliance for Flight Simulator Qualification. However, it is important that both the competent 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 Subparagraph 4.6 below.

4.5 STD operators who are unfamiliar with the evaluation process are advised to contact the Authority.

4.6 Typical Test Profile (2 hours)

Note: The Typical Test Profile should be flown at helicopter masses at, or close to, the maximum allowable mass for the ambient atmospheric conditions. Those ambient conditions should be varied from Standard Atmosphere to test the validity of the limits of temperature and pressure likely to be required in the practical use of the simulator.



AMC STD 1H.025 STD Operator's Quality System
See YCAR-STD 1H.025

1 Introduction

1.1 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 1H 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 operator to monitor compliance with YCAR-STD 1H, 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 provisions of YCAR-STD 1H;

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 provisions 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. Helicopter modifications management.

4.7 Audit 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 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) What corrective actions are 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. Responses 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 relative to the agreement 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.

AMC STD 1H.030 Flight Simulators qualified on or after 1 January 2005
See YCAR-STD 1H.030

Note : AMC STD 1H.030 is an Acceptable Means of Compliance. The structure and numbering of this AMC departs from normal layout due to the complexity of the technical content and the need to retain harmonization with the ICAO Manual of criteria for the Qualification of Flight Simulators (1995 or as amended), FAA AC 120-63 and YCAR-STD 1A.

1. Introduction

1.1 Purpose. This AMC establishes the standards which define the performance and documentation requirements for the evaluation of helicopter Flight Simulators used for training, testing and checking of flight crew-members. These test standards and methods of compliance were derived from extensive experience of competent 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 helicopters also have encouraged broader use of advanced simulation. Flight Simulators can provide more in-depth training than can be accomplished in helicopters and provide a safe and suitable learning environment. Fidelity of modern simulators is sufficient to permit pilot assessment in them with the assurance that the observed behaviour will transfer to the helicopter. Fuel conservation and reduction in adverse environmental effects are important by-products of simulator use.

1.2.2 The methods, procedures, and testing standards contained in this AMC are the result of the experience and expertise of Authorities, STD operators and manufacturers of helicopters and STDs. In any case early contact with the Authority is advised at the initial stage of simulator build to verify the acceptability of the design and validation data.

1.3 Levels of Flight Simulator qualification

Parts 2, 3 and 4 of this AMC describe the minimum requirements for qualifying Level A, B, C and D helicopter Flight Simulators.

1.4 Terminology. Terminology and abbreviations of terms as used in this AMC are contained in AMC-STD 1H.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 simulator's longitudinal, lateral and rotational responses; performance in take-off, climb, cruise, descent, approach, landing ; specific operations; control checks; cockpit and instructor station function checks; and certain additional requirements depending on the complexity or Qualification Level of the 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 simulator will be subjected to Validation, and Functions and Subjective Tests listed in Part 3 and 4 of this AMC. Validation Tests are used to objectively compare simulator and helicopter data to ensure that they agree within specified tolerances. Functions and Subjective Tests provide a basis for evaluating 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 should not be confused with simulator design tolerances. Validation Test tolerances are the maximum acceptable for Flight Simulator qualification.

1.5.4 For initial qualification testing of Flight Simulators the helicopter 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 helicopter development programmes, the helicopter manufacturer's Predicted Data partially validated by Flight Test Data, may be used in the interim qualification of the simulator. However, the simulator should be re-evaluated following the release of the manufacturer's data resulting from final airworthiness approval of the helicopter. The schedule should be as agreed by the Authority, STD operator, simulator manufacturer, and helicopter manufacturer. For more details, see AMC and IEM STD 1H.045.

1.5.6 STD operators seeking Initial or upgrade evaluation of a simulator should be aware that performance and handling data for older helicopters may not be of sufficient quality to meet some of the test standards contained in this AMC. In this instance it may be necessary for an STD 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 the 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 AMC.

1.6.2 The STD operator should submit a QTG which includes:

(a) A title page with STD operator and approval Authority signature blocks.

(b) A Flight Simulator information page (for each configuration in the case of convertible Flight Simulators) providing:

(i) STD operator's simulator identification number.

(ii) Helicopter 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, testing and checking capability of the 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. SOCs 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 AMC-STD 1H.030-2 "Simulator Standards" and AMC-STD 1H.030-3 "Simulator Validation Tests" "Comments" column, for SOC requirements.

(h) Recording procedures and required equipment for the Validation Tests.

(i) The following items for each Validation Test designated in Part 3 of this AMC:

(i) Test Title. This should be short and definitive, based on the test title referred to in AMC-STD 1H.030-3.

(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 helicopter 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 cockpit 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 helicopter 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 simulator Validation Test results obtained by the STD operator from the simulator. Tests run on a computer which is independent of the simulator are not acceptable.

(xi) Source Data. Copy of the helicopter source data, clearly marked with the document, page number, issuing Authority, and the test number and title as specified in (a). Computer generated displays of Flight Test Data overplotted with simulator data are insufficient on their own for this requirement.

(xii) Comparison of results. An acceptable means of easily comparing simulator test results with the Validation Flight Test Data. The preferred method is overplotting.

(j) A Statement of Compliance (SOC) covering the "Functions and Subjective Tests" designated in Part 4 of this AMC.

Note : The STD operator's simulator test results should be recorded on a multichannel 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 helicopter 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. Helicopter 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 AMC STD 1H.030-3. The test guide will provide the documented proof of compliance with the simulator Validation Tests in AMC STD 1H.030-3. For tests involving time histories, Flight Test Data sheets or transparencies thereof and, simulator test results should be clearly marked with appropriate reference points to ensure an accurate comparison between the simulator and helicopter 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 helicopter data. The cross plotting of the STD

operator's simulator data to helicopter data is essential to verify simulator performance in each test. The evaluation serves to validate the STD operator's Flight Simulator test results.

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 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 simulator is representative of the respective helicopter.

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 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 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 (see para 4 below) - 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. Flight Simulator standards

2.1 General

The test should show that the requirement has been attained. In the following tabular listing of Flight Simulator standards, required statements of compliance are indicated in the comments column.

Wherever the term runway is used, it includes runways and FATO/TLOF.

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
a. Cockpit, a full scale replica of the helicopter simulated. Direction of movement of controls and switches identical to that in the helicopter. The cockpit, for 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 crew member duty stations and those required bulkheads aft of the pilot seats are also considered part of the cockpit and should replicate the helicopter.	✓	✓	✓	✓	
b. Circuit breakers that affect procedures and/or result in observable cockpit indications properly located and functionally accurate.	✓	✓	✓	✓	
c. Effect of aerodynamic changes for various combinations of airspeed and power normally encountered in flight corresponding to actual flight conditions, including the effect of change in helicopter attitude, aerodynamic and propulsive forces and moments, altitude, temperature, mass, centre of gravity location, and configuration.	✓	✓	✓	✓	
d. All relevant cockpit instrument indications automatically respond to control movement by a crewmember, simulated helicopter performance, or external simulated environmental effects upon the simulated helicopter, e.g. turbulence.	✓	✓	✓	✓	Numerical values should be presented in accordance with the ICAO annex 5 standard units table.
e. Communications, Navigation, and Caution and Warning equipment corresponding to that installed in the helicopter with operation within the tolerances prescribed for the applicable airborne equipment.	✓	✓	✓	✓	

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
f. In addition to the flight crewmember stations, at least two suitable seats for the instructor/examiner and Authority inspector. The Authority will consider options to this standard based on unique cockpit configurations. These seats should provide adequate vision to the pilot's panel and forward windows. Observer seats need not represent those found in the helicopter but should be equipped with similar positive restraint devices.	✓	✓	✓	✓	
g. Simulator systems should simulate the applicable helicopter system operation, both on the ground and in flight. Systems should be operative to the extent that normal, abnormal, and emergency operating procedures appropriate to the simulator application can be accomplished.	✓	✓	✓	✓	
h. Controls to enable the operator's instructor/examiner to operate all required systems by inserting abnormal or emergency conditions into the helicopter systems.	✓	✓	✓	✓	
i. Control forces and control travel which correspond to that of the replicated helicopter. Control forces should react in the same manner as in the helicopter under the same flight conditions.	✓	✓	✓	✓	For Level A only static control force characteristics need to be tested.
j. (1) Significant cockpit sounds which result from pilot actions corresponding to those of the helicopter.	✓	✓	✓	✓	Statement of Compliance required.
(2) Sound of precipitation, windshield wipers, and significant cockpit sounds which include engines, transmission, rotors and other aircraft systems during normal operation as well as the sound resulting from a blade strike and a crash when operating the helicopter in excess of limitations.			✓	✓	Crash sounds may be generic
k. Realistic amplitude and frequency of cockpit acoustic environment.				✓	Objective steady-state tests required.

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
l. Ground handling and aerodynamic programming to include the following: (1) Ground effect - hover and transition IGE. (2) Ground reaction -- reaction of the helicopter upon contact with the landing surface during landing to include strut deflections, tire or skid friction, side forces, and other appropriate data, such as weight and speed, necessary to identify the flight condition and configuration. (3) Ground handling characteristics – control inputs to include braking, deceleration turning radius and the effects of crosswind.	✓	✓	✓	✓	Level A can utilise generic simulation of ground effect and ground handling.
m. Instructor controls for					
(1) Wind speed and direction	✓	✓	✓	✓	
(2) Turbulence	✓	✓	✓	✓	
(3) Other atmospheric models to support the required training.				✓	Examples : Mountain downdrafts, general wind patterns around structures.
n. Representative stopping and directional control forces for at least the following landing surface conditions based on helicopter related data, for a running landing. (1) Dry (2) Wet (soft surface and hard surface) (3) Icy (4) Patchy Wet (5) Patchy Icy			✓	✓	Statement of Compliance. Objective tests required for (1); subjective check for (2) , (3), (4), and (5).
o. Representative brake and tire failure dynamics.			✓	✓	Statement of Compliance.

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
p. A means for quickly and effectively testing simulator programming and hardware. This may include an automated system which could be used for conducting at least a portion of the tests in the QTG.	✓	✓			Statement of Compliance required.
Self-testing for simulator hardware and programming to determine compliance with the simulator performance tests as prescribed in Part 3. Evidence of testing should include simulator number, date, time, conditions, tolerances, and the appropriate dependent variables portrayed in comparison with the helicopter standard. Automatic flagging an of "out-of-tolerance" situations is encouraged.			✓	✓	Statement of Compliance required
q. Simulator computer capacity, accuracy, resolution, and dynamic response sufficient for the qualification level sought.	✓	✓	✓	✓	Statement of Compliance required.

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
r. Cockpit control dynamics which replicate the helicopter simulated. Free response of the controls shall match that of the helicopter within the tolerance given in paragraph 3. Initial and upgrade evaluation will include control free response (cyclic, collective, and pedal) measurements recorded at the controls. The measured responses must correspond to those of the helicopter in ground operations, hover, climb, cruise, and autorotation. (1) For helicopters with irreversible control systems, measurements may be obtained on the ground. Engineering validation or helicopter manufacturer rationale will be submitted as justification for ground test or to omit a configuration. (2) For Flight Simulators requiring static and dynamic tests at the controls, special test fixtures will not be required during the initial evaluations if the STD operator's QTG shows both test fixture results and alternate test method results, such as computer data plots, which were obtained concurrently. Use of the alternate method during initial evaluation may then satisfy this test requirement.		✓	✓	✓	

SIMULATOR STANDARDS	SIMULATOR LEVEL A	B	C	D	COMMENTS
s. Relative response of the visual system, cockpit instruments and initial motion system response should be coupled closely to provide integrated sensory cues. These systems should respond to abrupt pitch, roll, and yaw inputs at the pilot's position within the permissible delay, but not before the time, when the helicopter would respond under the same conditions. Visual scene changes from steady state disturbance should occur within the system dynamic response limit but not before the resultant motion onset. The test to determine compliance with these requirements should include simultaneously recording the output from the pilot's cyclic, collective and pedals, the output from an 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 delays), and the output signal to the pilot's attitude indicator or an equivalent test approved by the Authority. The test results in a comparison of a recording of the simulator's response with actual helicopter response data. The intent is that the simulator system Transport Delays or time lags are less than the permissible delay and that the motion and visual cues relate to actual helicopter responses. For helicopter response, acceleration in the appropriate rotational axis is preferred. As an alternative, a Transport Delay test may be used to demonstrate that the simulator system does not exceed the permissible delay.	✓	✓	✓	✓	Test required. See paragraph 3.3 - 6.a. For level 'A' & 'B' simulators the maximum permissible delay is 150 milliseconds For level 'C' and 'D' simulators the maximum permissible delay is 100 milliseconds

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
s. (continued) This test should 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 should be provided by a pilot flight control input. The test mode should permit normal computation time to be consumed and should 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 (systems) responses. It need only be measured once in each axis, being independent of flight conditions.					
t. Aerodynamic modelling which includes ground effect and sideslip.	✓				Level A aerodynamic data can be representative/generic and need not necessarily be based on flight test data.
Aerodynamic modelling which includes ground effect and sideslip based on helicopter flight test data.		✓			
Aerodynamic modelling which includes ground effect, effects of airframe and rotor icing (if applicable), aerodynamic interference effects between the rotor wake and fuselage, influence of the rotor on control and stabilization systems, and representations of nonlinearities due to sideslip, vortex ring and retreating blade stall based on approved helicopter flight test data. (See IEM to AMC STD 1H.030, para 2.1)			✓	✓	Statement of Compliance. Tests required. Nonlinearities due to sideslip are normally included in the simulator aerodynamic model, but the Statement of Compliance should address each of them. Separate tests for aerodynamic interference effects and rotor influence. A Statement of Compliance and demonstration of icing effects (if applicable) are required.
u. Timely permanent update of simulator hardware and programming subsequent to helicopter modification.	✓	✓	✓	✓	
v. Daily preflight documentation either in the daily log or in a location easily accessible for review.	✓	✓	✓	✓	

Motion system
(See IEM to AMC STD 1H.030 para 2.2)

SIMULATOR STANDARDS	SIMULATOR LEVEL A	B	C	D	COMMENTS
a. Motion (acceleration) cues perceived by the pilot representative of the helicopter motions, e.g. touchdown cues should be a function of the simulated rate of descent.	✓	✓	✓	✓	Motion tests to demonstrate that each axes onset cues are properly phased with pilot input and helicopter response.
b. A motion system :					Statement of Compliance required. Tests required.
(1) Having a minimum of 3 degrees of freedom (pitch, roll, heave) to accomplish the required task.	✓				
(2) A 6 degrees of freedom synergistic platform motion system.		✓	✓	✓	For Level B, a reduced motion performance envelope is acceptable.
c. A means of recording the motion response time for comparison with helicopter data.	✓	✓	✓	✓	See Para 2.1.s above.
d. Special effects programming to include the following:	✓	✓	✓	✓	For level A it may be of a generic nature sufficient to accomplish the required tasks.
(1) Runway rumble, oleo deflections, effects of groundspeed and uneven surface characteristics.					
(2) Buffet due to translational lift.					See IEM to AMC 1H.030 para 2.2
(3) Buffet during extension and retraction of landing gear.					
(4) Buffet due to high speed and retreating blade stall.					
(5) Buffet due to vortex ring.					
(6) Representative cues resulting from; (i) touchdown (ii) translational lift.					
(7) Antitorque device ineffectiveness.					
(8) Buffet due to turbulence.					

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
e. Characteristic vibrations/buffets that result from operation of the helicopter and which can be sensed in the cockpit. Tests with recorded results which allow the comparison of relative amplitudes versus frequency in the longitudinal, lateral and vertical axes with helicopter data. Simulated cockpit vibrations to include seat(s), flight controls and instrument panel(s), although these need not be tested independently.				✓	Statement of Compliance Tests required. Steady state tests are acceptable. See IEM to AMC 1H.030, para 2.2 on Vibration Platforms for Helicopter STDs.

2.3 Visual System
(See IEM to AMC STD 1H.030, para 2.3)

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
a. Visual system capable of meeting all the standards of this Part and Parts 3 & 4 (Validation and Functions and Subjective Tests) as applicable to the level of qualification requested by the STD operator.	✓	✓	✓	✓	The choice of the display system and of the field of view requirements should fully consider the intended use of the STD. The balance between training and testing/ checking may influence the choice and geometry of the display system. In addition the diverse operational requirements should be addressed.
b. Visual system capable of providing at least a 45 degree horizontal and 30 degree vertical field of view per pilot.	✓				
Visual system capable of providing at least a 75 degrees horizontal and 40 degrees vertical field of view per pilot.		✓			
Continuous minimum visual field of view of 150 degrees horizontal and 40 degrees vertical per pilot.			✓		A minimum of 75 degrees horizontal field of view on either side of the zero degree azimuth line relative to the helicopter fuselage.
Continuous minimum visual field of view of 180 degrees horizontal and 60 degrees vertical per pilot.				✓	A minimum of 75 degrees of horizontal field of view on either side of zero degrees azimuth line relative to the helicopter fuselage is required. This will allow an offset per side of the horizontal field of view if required for the training. Where training tasks require extended fields of view beyond the 180 degrees x 60 degrees, then such extended fields of view shall be provided.
c. A means of recording the visual response time for visual systems as required by paragraph 3.3 - 6.a. below.	✓	✓	✓	✓	

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
d. Verification of visual ground segment and visual scene content at a decision height on landing approach. The QTG should contain appropriate calculations and a drawing showing the pertinent data used to establish the helicopter location and visual ground segment. Such data should include, but is not limited to: (1) Aerodrome and runway used. (2) Glide slope transmitter location for the specified runway. (3) Position of the glide slope receiver antenna relative to the helicopter landing gear. (4) Approach and runway light intensity settings. (5) Helicopter landing gear height. The above parameters should be presented for the helicopter in the landing configuration and a main wheel height of 30m (100 ft) above the touchdown zone. The visual ground segment and scene content should be determined for a runway visual range of 300m (980 ft).	✓	✓	✓	✓	See paragraph 3.3 - 5a. below
e. Visual cues to assess rate of change of height, translational displacements and rates, during takeoff and landing.	✓	✓			For Level 'A' , Visual cueing sufficient to support changes in approach path by using FATO perspective.
f. Visual cues to assess rate of change of height, height AGL, translational displacements and rates, during takeoff, low altitude/low airspeed manoeuvring, hover, and landing.			✓	✓	
g. Test procedures to quickly confirm visual system colour, RVR, focus, intensity, level horizon, and attitude as compared with the simulated attitude indicator.	✓	✓	✓	✓	Statement of Compliance required. Tests required. See paragraph 3.3 - 5b below.
h. Night/Dusk scene	✓	✓	✓	✓	

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
i. A minimum of ten levels of occulting. This capability should be demonstrated by a visual model through each channel.			✓	✓	Statement of Compliance required. Tests required. See, paragraph 3.3 - 5b below.
j. Surface resolution will be demonstrated by a test pattern of objects shown to occupy a visual angle of 3 arc minutes in the visual scene from the pilot's eyepoint. This should be confirmed by calculations in the statement of compliance.			✓	✓	See paragraph 3.3 - 5b below.
k. Lightpoint size - not greater than 6 arc minutes measured in a test pattern consisting of a single row of lightpoints reduced in length until modulation is just discernable, a row of 40 lights will form a 4 degree angle or less.			✓	✓	See, paragraph 3.3 - 5b below. This is equivalent to a light point resolution of 3 arc minutes.
l. Lightpoint contrast ratio - not less than 25:1 when a square of at least 1 degree filled with lightpoints (i.e. lightpoint modulation is just discernable) is compared with the adjacent background.			✓	✓	
m. Daylight, dusk, and night visual scenes with sufficient scene content to recognise aerodromes, heliports, terrain, and major landmarks around the Final Approach and Take-off (FATO) area and to successfully accomplish low airspeed/low altitude manoeuvres to include lift-off, hover, translational lift, landing and touchdown. The daylight visual scene should be part of a total daylight cockpit/flight deck environment which at least represents the amount of light in the cockpit/flight deck on an overcast day.			✓	✓	Statement of Compliance required. Tests required. See paragraph 3.3 - 5b below.

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
m. (continued) Daylight visual system is defined as a visual system capable of producing, as a minimum, full colour presentations, scene content comparable in detail with that produced by 6 000 polygons for daylight and 7 000 light points for night and dusk scenes for the entire visual system, 20 cd/m² (6 ft-Lamberts) of light measured at the pilot's eye position (Highlight Brightness), and a display which is free of apparent quantization and other distracting visual effects whilst the simulator is in motion. Full colour texture shall be used to enhance visual cue perception for illuminated landing surfaces. The simulator cockpit/flight deck ambient lighting should be dynamically consistent with the visual scene displayed. For daylight scenes, such ambient lighting should not 'washout' the displayed visual scene nor fall below 17 cd/m² (5 foot Lamberts) of light as reflected from an approach plate at knee height at the pilot's station. All brightness and resolution requirements should be validated by an Objective Test and will be retested at least yearly. Testing may be accomplished more frequently if there are indications that the performance is degrading on an accelerated basis. Compliance of the brightness capability may be demonstrated with a test pattern of white light using a spot photometer. Note: The following tests are conducted for daylight visual scenes. When conducting these tests cockpit ambient light levels should be maintained at Level D values.					The ambient lighting should provide an even level of illumination which is not distracting to the pilot. For Level C, the following is required : (a) 4 000 polygons (b) 5 000 light points (c) 4ft Lamberts Freedom of apparent quantization and other distracting visual effects are also applicable for Levels A and B.

SIMULATOR STANDARDS	SIMULATOR LEVEL				COMMENTS
	A	B	C	D	
m. (continued) (1) Contrast Ratio. A raster drawn test pattern filling the entire visual scene (three or more channels) should consist of a matrix of black and white squares no larger than 10 degrees and no smaller than 5 degrees per channel 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/m² (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. (2) Highlight Brightness Test. Maintaining the full test pattern described in paragraph (1) above, superimpose a highlight on the centre white square of each channel and measure the brightness using the 1 degree spot photometer. Lightpoints are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable.					

3. Flight Simulator Validation Tests

3.1 General

3.1.1 Flight Simulator performance and system operation should be objectively evaluated by comparing the results of tests conducted in the Flight Simulator with helicopter data unless specifically noted otherwise. To facilitate the validation of the Flight Simulator, a multichannel recorder, line printer, or other appropriate recording device acceptable to the Authority should be used to record each Validation Test result. These recordings should then be compared with the helicopter source data.

3.1.2 Certain visual, sound and motion tests in this part 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.

3.1.3 The QTG provided by the STD operator should describe clearly and distinctly how the Flight Simulator will be set up and operated for each test. Use of a driver programme designed to automatically accomplish the tests is required for Level C and D Flight Simulators, and is encouraged for all other levels. 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.

3.1.4 The tests and tolerances contained in this part should be included in the operator's QTG. For helicopters certified prior to 1 January 2005, an STD operator may, after reasonable attempts have failed to obtain suitable Flight Test Data, indicate in the QTG 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. Submittals for approval of data other than flight test should include an explanation of validity with respect to available flight test information, which at any event should not be lower than the appropriate approved Flight Manual values.

3.1.5 The Table of Validation Tests of this part generally indicates the test results required. Unless noted otherwise, Flight Simulator tests should represent helicopter performance and handling qualities at operating weights and centres of gravity (cg) typical of normal operation. If a test is supported by helicopter data at one extreme weight or cg, another test supported by helicopter 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 cg or weight condition need not be repeated at the other extreme. Tests of handling qualities should include validation of stability augmentation and control augmentation devices.

3.1.6 Flight Simulators for augmented helicopters will be validated both in the unaugmented configuration (with the maximum permitted degradation in handling qualities) achieved through pilot accessible switches in the flight deck/cockpit and the augmented configuration. Where various levels of handling qualities result from degradation states, validation of the effect of the degradation is necessary. For those performance and static handling qualities tests where the primary concern, in the unaugmented configuration, is control position, unaugmented data are not required if the design of the system precludes any effect on control position. In those instances where the unaugmented helicopter response is divergent and non-repeatable, it may not be feasible to meet the specified tolerance. Alternative requirements for testing will be mutually agreed to between the operator and the Authority on a case by case basis.

3.2 Test requirements

3.2.1 The ground and flight tests required for qualification are listed in the Table of Validation Tests. Computer generated test results of the Flight Simulator should be provided for each test. The results should be produced on a multichannel recorder, line printer, or other appropriate recording device acceptable to the Authority. Time histories are required unless otherwise indicated in the table of Validation Tests.

3.2.2 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 helicopter data throughout a Time History, differences should be justified by providing a comparison of other related variables for the condition being assessed.

3.2.2.1 Parameters, Tolerances, and Flight Conditions. The Table of Validation Tests of para 3.3 below describes the parameters, tolerances, and flight conditions for Flight Simulator validation. When two tolerance values are given for a parameter, the less restrictive may be used unless indicated otherwise. Where tolerances are expressed as a percentage, then the percentage of the maximum operating range of a parameter will be used. If a flight condition or operating condition is shown which does not apply to the Qualification Level sought, it should be disregarded. Flight Simulator results should be labelled using the tolerances and units given.

3.2.2.2 Flight Condition Verification. When comparing the parameters listed to those of the helicopter, sufficient data should also be provided to verify the correct flight condition. For example, to show the control force is within ± 0·5 pound (0·224 daN) in a static stability test, data to show correct airspeed, power, thrust or torque, helicopter 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 helicopter, but airspeed, altitude, control input, helicopter configuration, and other appropriate data should also be given. All airspeed values should be clearly annotated as to indicated, calibrated, etc., and like values used for comparison.

3.2.2.3 For Level 'A' Flight Simulators, 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 helicopter to the satisfaction of the Authority. To facilitate future evaluations, sufficient parameters should be recorded to establish a reference.

3.3 Table of validation tests

Note 1: All tests must be conducted against approved data.

Note 2: For piston engines, suitable alternative parameters should be used, which have to be agreed with the Authority.

Note 3: CT&M in the Level A column means Correct Trend & Magnitude.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
1. PERFORMANCE **a. Engine Assessment** (1) Start Operations							
(i) Engine Start and acceleration (transient)	Light Off Time - ± 10% or ± 1 sec Torque - ± 5% Rotor Speed - ± 3% Fuel Flow -± 10% Gas Generator Speed - ± 5% Power Turbine Speed - ± 5% Turbine Gas Temp. ± 30℃	Ground Rotor Brake Used/ Not Used	CT&M	✓	✓	✓	Time histories of each engine from initiation of start sequence to steady state idle and from steady state idle to operating RPM.
(ii) Steady State Idle and Operating RPM Conditions	Torque - ± 3% Rotor Speed - ± 1·5% Fuel Flow - ± 5% Gas Generator Speed - ± 2% Power Turbine Speed - ± 2% Turbine Gas Temp. ± 20℃	Ground	CT&M	✓	✓	✓	Present data for both steady state idle and operating RPM conditions. May be a snapshot test.
(2) Power Turbine Speed Trim	± 10% of total change of power turbine speed or ± 0·5% change of rotor speed	Ground	CT&M	✓	✓	✓	Time history of engine response to trim system actuation (both directions).
(3) Engine and Rotor Speed Governing	Torque - ± 5% Rotor Speed - ± 1·5%	Climb/Descent	CT&M	✓	✓	✓	Collective step inputs. Can be conducted concurrently with climb and descent performance tests.
b. Ground Operations							

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
(1) Minimum Radius Turn	± 3 ft (0·9m) or 20% helicopter turn Radius	Ground		✓	✓	✓	If differential braking is used, brake force must be set at the helicopter flight test value
(2) Rate of Turn vs. Pedal Deflection or Nosewheel Angle	± 10% or ± 2°/sec Turn Rate	Ground		✓	✓	✓	
(3) Taxi	Pitch Attitude - ± 1·5° Torque - ± 3% Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	Ground	C T & M	✓	✓	✓	Control position and pitch attitude during ground taxi for a specific ground speed and direction, and density altitude.
(4) Brake Effectiveness	± 10% of time and distance.	Ground	C T & M	✓	✓	✓	
c. Takeoff							
(1) All engines	Airspeed - ± 3 kt Altitude - ± 20 ft (6·1 m) Torque - ± 3% Rotor Speed - ± 1·5% Pitch Attitude - ± 1·5° Bank Attitude - ± 2° Heading - ± 2° Longitudinal Control Position - ± 10% Lateral Control Position - ± 10% Directional Control Position - ± 10% Collective Control Position - ± 10%	Ground/lift off and initial climb	C T & M	✓	✓	✓	Time history of takeoff flight path as appropriate to helicopter model simulated [running take off for Level B. Takeoff from a hover for Levels C and D]. For Level B, criteria apply only to those segments at airspeeds above effective translational lift. Record data to at least 200 ft (61 meters) AGL/Vy whichever comes later

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
(2) One Engine Inoperative continued take-off	See 1.c. (1) above for tolerances and flight conditions			✓	✓	✓	Time history of takeoff flight path as appropriate to helicopter model simulated. Record data to at least 200 ft (61 meters) AGL /Vy whichever comes later
(3) One Engine inoperative rejected take off	Airspeed - ± 3 kt Altitude - ± 20 ft (6·1 m) Torque - ± 3% Rotor Speed - ± 1·5% Pitch Attitude - ± 1·5° Bank Attitude - ± 1·5° Heading ± 2° Longitudinal Control Position - ± 10% Lateral Control Position - ± 10% Directional Control Position - ± 10% Collective Control Position - ± 10% Distance: ± 7·5% or ± 30m (100ft)	Ground take off			✓	✓	Time history from the take off point to full stop. Test conditions near limiting performance.
d. Hover Performance	Torque - ± 3% Pitch Attitude - ± 1·5° Bank Attitude - ± 1·5° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	In Ground Effect (IGE) Out of Ground Effect (OGE)		✓	✓	✓	Light/heavy/ gross weights. May be a snapshot test. Refer to point 3.4.2 below for additional guidance.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
e. **Vertical Climb Performance**	Vertical Velocity - ± 100 fpm (0·50 m/sec) or 10% Directional Control Position - ± 5% Collective Control Position - ± 5%	From OGE Hover		✓	✓	✓	Light/heavy/ gross weights. May be a snapshot test.
f. **Level Flight Performance and Trimmed Flight Control Position**	Torque - ± 3% Pitch Attitude - ± 1·5° Sideslip Angle - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	Cruise Stability augmentation on/off	C T & M	✓	✓	✓	Two gross weight/cg and two speed combinations within the flight envelope. May be a snapshot test.
g. **Climb Performance and Trimmed Flight Control Position**	Vertical Velocity - ± 100 fpm (0.50 m/sec) or 10% Pitch Attitude - ± 1·5° Sideslip Angle - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5% Speed - ± 3kts	All engines operating One engine inoperative Both : Stability augmentation on/off	C T & M	✓	✓	✓	Two gross weight/cg combinations. Data presented at relevant climb power conditions. The achieved measured vertical velocity of the simulator cannot be less than the appropriate approved Flight Manual values.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
h. Descent							
(1) Descent Performance and Trimmed Flight Control Position	Torque - ± 3% Pitch Attitude - ± 1·5° Sideslip Angle - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	At or near 1 000 fpm Rate of Descent (RoD) at normal approach speed. Stability augmentation on/off	C T & M	✓	✓	✓	Two gross weight/CG combinations.
(2) Autorotation Performance and Trimmed Flight Control Position	Vertical Velocity - ± 100 fpm (0·50 m/sec) or 10% Rotor Speed - ± 1·5% Pitch Attitude - ± 1·5° Sideslip Angle - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	Steady descents Stability augmentation on/off		✓	✓	✓	Two gross weight/CG combinations. At normal operating RPM. Rotor speed tolerance only applies if collective control position is fully down. Speed sweep from approximately 50 kt to at least maximum glide distance airspeed. May be a snapshot test.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
i. Autorotational Entry	Torque - ± 3% Rotor speed - ± 3% Pitch Attitude - ± 2° Roll Attitude - ± 3° Heading - ± 5° Airspeed - ± 5 kt Altitude - ± 20ft (6·1m)	Cruise or climb			✓	✓	Time history of vehicle response to a rapid power reduction to idle. If cruise, data should be presented for the maximum range airspeed. If climb, data should be presented for the maximum rate of climb airspeed at or near maximum continuous power.
j. Landing							
(1) All Engines	Airspeed - ± 3 kt Altitude - ± 20 ft (6·1 m) Torque - ± 3% Rotor Speed - 1·5% Pitch Attitude - ± 1·5° Bank Attitude - ± 1·5° Heading ± 2° Longitudinal Control Position - ± 10% Lateral Control Position - ± 10% Directional Control Position - ± 10% Collective Control Position - ± 10%	Approach/ landing	C T & M	✓	✓	✓	Time history of approach and landing profile as appropriate to helicopter model simulated (running landing for Level B, approach to a hover for Levels C and D). For Levels A and B, criteria apply only to those segments at airspeeds above effective translational lift.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
(2) One Engine Inoperative	See 1.j.(1) above for tolerance and flight conditions		CT&M	✓	✓	✓	Include data for both Category A and Category B approaches and landing as appropriate to helicopter model simulated. For Levels A and B, criteria apply only to those segments at airspeeds above effective translational lift.
(3) Balked Landing/Missed Approach	See 1.j.(1) above for tolerances	Approach, one engine inoperative		✓	✓	✓	From a stabilized approach at the landing decision point (LDP).
(4) Autorotational Landing with Touchdown	Airspeed - ± 3kts Torque - ± 3% Rotor Speed - ±3% Altitude ± 20ft (6·1m) Pitch Attitude - ± 2° Bank Attitude - ± 2° Heading ± 5° Longitudinal Control Position - ± 10% Lateral Control Position - ± 10% Directional Control Position - ± 10% Collective Control Position - ± 10%	Approach/ Touchdown			✓	✓	Time history of autorotational deceleration and touchdown from a stabilized autorotational descent.
2. HANDLING QUALITIES **a. Control System Mechanical Characteristics**							

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
(1) Cyclic[1]	Breakout ± 0·25 lb (0·112 daN) or 25% Force ± 0·5 lb (0·224 daN) or 10%	Ground/Static Trim On/Off Friction Off Stability augmentation on/off	✓	✓	✓	✓	Uninterrupted control sweeps. Does not apply to aircraft hardware modular controllers.
(2) Collective/Pedals **	Breakout ± 0·5 lb (0·224 daN) or 10% Force ± 1·0 lb (0·448 daN) or 10%	Ground/Static Trim on/off Friction off Stability augmentation on/off	✓	✓	✓	✓	Uninterrupted control sweeps
(3) Brake Pedal Force vs. Position	± 5 lb (2·224 daN) or 10%	Ground/Static	CT&M	✓	✓	✓	Simulator computer output results may be used to show compliance.
(4) Trim System Rate (all applicable axes)	Rate - ± 10%	Ground/Static Trim on Friction off	✓	✓	✓	✓	Tolerance applies to recorded value of trim rate.
(5) Control Dynamics (all axes)	± 10% of time for first zero crossing and ± 10 (N+1)% of period thereafter ± 10% amplitude of first overshoot ± 20% of amplitude of 2nd and subsequent overshoots greater than 5% of initial displacement ± 1 overshoot	Hover/Cruise Trim on Friction off Stability augmentation on/off		✓	✓	✓	Control dynamics for irreversible control systems may be evaluated in a ground/static condition. Data should be for a normal control displacement in both directions in each axis (approximately 25% to 50% of full throw). N is the sequential period of a full cycle of oscillation. Refer to 3.4.1 below.

** Cyclic, collective, and pedal position vs. force shall be measured at the control. An alternate method acceptable to the Authority in lieu of the test fixture at the controls would be to instrument the simulator in an equivalent manner to the flight test helicopter. The force position data from instrumentation can be directly recorded and matched to the helicopter data. Such a permanent installation could be used without requiring any time for installation of external devices.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
(6) Freeplay	± 0·10 in (2·5mm)	Ground/Static Friction off		✓	✓	✓	Applies to all controls.
b. Low Airspeed Handling Qualities (1) Trimmed Flight Control Positions	Torque - ± 3% Pitch Attitude - ± 1·5° Bank Attitude - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	Translational Flight IGE. Sideward/ rearward/ forward Stability augmentation on/off			✓	✓	Several airspeed increments to translational airspeed limits and 45 kt forward. May be a snapshot test.
b. (continued) (2) Critical Azimuth	Torque - ± 3% Pitch Attitude - ± 1·5° Bank Attitude - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	Stationary Hover Stability augmentation on/off			✓	✓	Present data for three relative wind directions (including the most critical case) in the critical quadrant. May be a snapshot test.
(3) Control Response (i) Longitudinal	Pitch Rate -± 10% or ± 2°/sec Pitch Attitude Change - ± 10% or ± 1·5°	Hover Stability augmentation on/off			✓	✓	Step control input. Off axis response must show correct trend for unaugmented cases.
(ii) Lateral	Roll Rate - ± 10% or ± 3°/sec Roll Attitude Change - ± 10% or ± 3°	Hover Stability augmentation on/off			✓	✓	Step control input. Off axis response must show correct trend for unaugmented cases.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
(iii) Directional	Yaw Rate - ± 10% or ± 2°/sec Heading Change - ± 10% or ± 2°	Hover Stability augmentation on/off			✓	✓	Step control input. Off axis response must show correct trend for unaugmented cases.
(iv) Vertical	Normal Acceleration - ± 0·1g	Hover Stability augmentation on/off			✓	✓	Step control input. Off axis response must show correct trend for unaugmented cases.
c. Longitudinal Handling Qualities							
(1) Control Response	Pitch Rate - ± 10% or ± 2°/sec Pitch Attitude Change - ± 10% or ± 1.5°	Cruise Stability augmentation on/off		✓	✓	✓	Two cruise airspeeds to include minimum power required speed. Step control input. Off axis response must show correct trend for unaugmented cases.
(2) Static Stability	Longitudinal Control Position - ± 10% of change from trim or ± 0·25 in (6·3 mm) or Longitudinal Control Force - ± 0·5 lb (0·224 daN) or ± 10%	Cruise or Climb Autorotation Stability augmentation on/off		✓	✓	✓	Minimum of two speeds on each side of the trim speed. May be a snapshot test.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
(3) Dynamic Stability (i) Long Term Response	± 10% of Calculated Period ± 10% of Time to 1/2 or Double Amplitude or ± 0·2 of Damping Ratio	Cruise Stability augmentation on/off		✓	✓	✓	Test should include three full cycles (6 overshoots after input completed) or that sufficient to determine time to ½ or double amplitude, whichever is less. For non-periodic response the time history should be matched.
(ii) Short Term Response	± 1.5° Pitch or ± 2°/sec Pitch Rate ± 0·1 g Normal Acceleration	Cruise or Climb Stability augmentation on/off		✓	✓	✓	Two airspeeds. Time history to validate short helicopter response due to control pulse input. Check to stop 4 seconds after completion of input.
(4) Manoeuvring Stability	Longitudinal Control Position - ± 10% of change from trim or ± 0·25 in (6·3 mm) or Longitudinal Control Force - ± 0·5 lb (0·224 daN) or ± 10%	Cruise or Climb Stability augmentation on/off Left and right turns	C T & M	✓	✓	✓	Force may be a cross plot for irreversible systems. Two airspeeds. May be a snapshot test. Approximately 30° and 45° bank attitude data should be presented.
(5) Landing Gear Operating Time	± 1 sec	Takeoff (Retraction) Approach (Extension)	✓	✓	✓	✓	
d. Lateral and Directional Handling Qualities (1) Control Response							Two airspeeds to include one at or near the minimum power required speed.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
(i) Lateral	Roll Rate - ± 10% or ± 3°/sec Roll Attitude Change - ± 10% or ± 3°	Cruise Stability augmentation on/off		✓	✓	✓	Step control input. Off axis response must show correct trend for unaugmented cases.
d. (1) (continued) (ii) Directional	Yaw Rate -± 10% or ± 2°/sec Yaw Attitude Change - ± 10% or ± 2°	Cruise Stability augmentation on/off		✓	✓	✓	Two airspeeds to include one at or near the minimum power required speed. Step control input. Off axis response must show correct trend for unaugmented cases.
(2) Directional Static Stability	Lateral Control Position - ± 10% of change from trim or ± 0·25in (6·3 mm) or Lateral Control Force - ± 0·5 lb (0·224 daN) or ± 10% Roll Attitude - ± 1·5° Directional Control Position - ± 10% of change from trim or ± 0·25 in (6·3 mm) or Directional Control Force - ± 1 lb (0·448 daN) or ± 10% Longitudinal Control Position - ±10% of change from trim or ± 0·25in (6·3mm)	Cruise or Climb/Descent Stability augmentation on/off	C T & M	✓	✓	✓	Steady heading sideslip. Minimum of two sideslip angles on either side of the trim point. Force may be a cross plot for irreversible control systems. May be a snapshot test.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
(3) Dynamic Lateral and Directional Stability							
(i) Lateral-Directional Oscillations	± 0·5 sec or ± 10% of Period ± 10% of Time to ½ or Double Amplitude or ± 0·02 of Damping Ratio ± 20% or ± 1 sec of Time Difference between peaks of Bank and Sideslip	Cruise or Climb Stability augmentation on/off	C T & M	✓	✓	✓	Two airspeeds. Excite with cyclic or pedal doublet. Test should include six full cycles (12 overshoots after input completed) or that sufficient to determine time to ½ or double amplitude, whichever is less. For non-periodic response, time history should be matched.
(ii) Spiral Stability	Correct Trend on Bank – ± 2% or ± 10% in 20 sec	Cruise or Climb Stability augmentation on/off	C T & M	✓	✓	✓	Time history of release from pedal only or cyclic only turns in both directions. Terminate check at zero bank or unsafe attitude for divergent cases.
(iii) Adverse/ Proverse Yaw	Correct Trend on sideslip - ± 2°	Cruise or Climb Stability augmentation on/off	C T & M	✓	✓	✓	Time history of initial entry into cyclic only turns in both directions. Use moderate cyclic input rate.
3. ATMOSPHERIC MODELS							
(1) A test to demonstrate turbulence models.	None	Take-off, Cruise and Landing	✓	✓	✓	✓	
(2) Tests to demonstrate other atmospheric models to support the required training						✓	
4. MOTION SYSTEM**							

** For Level A, if more than the three specified degrees of freedom (DOF) are used, then the corresponding Level B performance standards should be used.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
a. Motion Envelope							
(1) Pitch		N/A					
(i) Displacement							
± 20°			✓	✓			
± 25°					✓	✓	
(ii) Velocity							
± 15°/sec			✓	✓			
± 20°/sec					✓	✓	
(iii) Acceleration							
± 75°/sec²			✓	✓			
± 100°/sec²					✓	✓	
(2) Roll							
(i) Displacement							
± 20°			✓	✓			
± 25°					✓	✓	
(ii) Velocity							
± 15°/sec			✓	✓			
± 20°/sec					✓	✓	
(iii) Acceleration							
± 75°/sec²			✓	✓			
± 100°/sec²					✓	✓	
(iv) Displacement							
± 25°		N/A		✓	✓	✓	
3. Yaw		N/A					
(i) Displacement							
± 25°				✓	✓	✓	
(ii) Velocity							
± 15°/sec				✓			
± 20°/sec					✓	✓	
(iii) Acceleration							
± 75°/sec²				✓			
± 100°/sec²					✓	✓	
4. Vertical							
(i) Displacement							
± 22 in			✓	✓			
± 34 in					✓	✓	
(ii) Velocity							
± 16 in/sec			✓	✓			
± 24 in/sec					✓	✓	

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
(iii) Acceleration							
± 0·6 g			✓	✓			
± 0·8 g					✓	✓	
(5) Lateral		N/A					
(i) Displacement							
± 26 in				✓			
± 45 in					✓	✓	
(ii) Velocity							
± 20 in/sec				✓			
± 28 in/sec					✓	✓	
(iii) Acceleration							
± 0·4 g				✓			
± 0·6 g					✓	✓	
(6) Longitudinal							
(i) Displacement							
± 27 in				✓			
± 34 in					✓	✓	
(ii) Velocity							
± 20 in/sec				✓			
± 28 in/sec					✓	✓	
(iii) Acceleration							
± 0·4 g				✓			
± 0·6 g					✓	✓	
(7) Initial Rotational Acceleration Rate, All axes							
± 225 °/sec²/sec			✓	✓			All relevant rotational axes
± 300 °/sec²/sec					✓	✓	All rotational axes
(8) Initial Linear Acceleration Rate							
(i) Vertical							
± 4 g/sec			✓	✓			
± 6 g/sec					✓	✓	
(ii) Lateral							
± 2 g/sec				✓			
± 3 g/sec					✓	✓	

TESTS		TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
	(iii) Longitudinal ± 2 g/sec ± 3 g/sec				✓	 ✓	 ✓	
b.	*Frequency Response* Band, Hz 0·1 to 1·0 1·1 to 3·0	Phase, deg / Amplitude Ratio, D.B. 0 to – 20 ± 2 0 to – 40 ± 4	N/A		✓	✓	✓	All six axes
c.	**Leg Balance** or Parasitic Acceleration	1·5° 0·02g or 3°/sec² (peak)	N/A		✓	✓	✓	The phase shift between a datum jack and any other jack shall be measured using a heave (vertical) signal of 0·5 Hz at ± 0·25g. The acceleration in the other 5 axes should be measured using a heave (vertical/signal) of 0·5Hz at ± 0·1g.
d.	**Turn Around**	0·05 g	N/A		✓	✓	✓	The motion base shall be driven sinusoidally in heave through a displacement of 6 in (150 mm) peak to peak at a frequency of 0·5 Hz. Deviation from the desired sinusoidal acceleration shall be measured.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
e. Characteristic vibrations/ buffet							
(1) Vibrations Tests to include 1/Rev and n/Rev vibrations where n is the number of main rotor blades.	+3/-6db or ±10% of nominal vibration level in flight cruise and correct trend (see comment).	On ground (idle, flight Nr); Low and high speed transition to and from hover; Level flight; Climb/Descent (including vertical climb); Autorotation; Steady turns;				✓	Correct trend refers to a comparison of vibration amplitudes between different manoeuvres. Example: If the 1/Rev vibration amplitude in the helicopter is higher during steady state turns than in level flight, this increasing trend shall be demonstrated in the simulator.
(2) Buffet A test with recorded results is required for characteristic buffet motion which can be sensed in the cockpit.	+3/-6db or ±10% of nominal vibration level in flight cruise and correct trend (see comment).	On ground and in flight.				✓	The recorded test results for characteristic buffets should allow the checking of relative amplitude for different frequencies. For atmospheric disturbance general purpose models are acceptable which approximate demonstrable flight test data.
f. Motion Cue Repeatability				✓	✓	✓	See para 3.4.3 below.
5. VISUAL SYSTEM (Note: Refer to para 4.3 of this subpart for additional visual tests.							

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
a. Visual Ground Segment (VGS)	± 20% of calculated VGS. Approach lights should be visible if they are in the visual segment (see example under "Comments")	Static at 100 ft (30·5 m) landing gear height above touchdown zone on glideslope RVR = 300 metres or 980ft	✓	✓	✓	✓	The QTG should indicate the source of data, i.e., ILS G/S antenna location, pilot eye reference point, cockpit cutoff angle, etc., used to make visual scene ground segment content calculations. Tolerance example: If the calculated VGS for the helicopter is 256 m (840ft), the 20% tolerance of 51m (168ft) may be applied at the near or far end of the simulator VGS or may be split between both as long as the total of 168 ft is not exceeded.
b. Display System Tests							
(1) Visual System Colour	Demonstration model	Not Applicable	✓	✓	✓	✓	
(2) Visual Display Focus and Intensity	Demonstration model	Not Applicable	✓	✓	✓	✓	
(3) Visual Attitude vs Simulator Attitude Indicator (Pitch and Roll Horizon)	Demonstration model	Not Applicable	✓	✓	✓	✓	
b. (continued)							
(4) Demonstrate 10 levels of occulting through each channel of the system	Demonstration model	Not applicable			✓	✓	

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
(5) Daylight Scene Display Brightness of 20 cd/m^2 (6 foot-Lamberts) on the display and 17 cd/m^2 (5 foot-Lamberts) measured at the design eye point.	Demonstration model	Not Applicable			✓	✓	For Level C 4 foot Lamberts is acceptable. See para. 3.4.4 below.
(6) Contrast Ratio 5:1	Demonstration model	Not Applicable			✓	✓	See para. 3.4.4 below.
(7) Surface Resolution 3 arc minutes	Demonstration model	Not Applicable			✓	✓	See para. 3.4.4 below.
(8) Lightpoint Size - not greater than 6 arc minutes	Demonstration model	Not Applicable			✓	✓	This is equivalent to a light point resolution of 3 arc minutes.
c. Visual Feature Recognition							
(1) Runway definition, Strobe Lights, Approach Lights, Edge White Lights, Visual Approach and Guidance Lights.	8 km (4·3NM) minimum from the runway threshold	Approach	✓	✓	✓	✓	Within final picture resolution, the distances at which features are visible for tests (1) through (4) should not be less than those indicated in the specified test. Operators should indicate the light intensity level used for the test.
c. (continued)							
(2) Runway Centreline Lights or FATO/TLOF edge lights	5 km (2·7NM) minimum from the runway threshold edge lights 5 km (2·7NM) minimum from the FATO/TLOF edge lights	Approach	✓	✓	✓	✓	Same as c (1) above Approach angles up to 12 degrees should be covered.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
(3) Threshold Lights, Touchdown Zone Lights and Taxiway Definition Lights	3 km (1·6NM) minimum from the runway threshold edge lights	Approach	✓	✓	✓	✓	Same as c (1) above
(4) Runway Markings, FATO/TLOF markings	Night/Dusk scenes within range of landing lights.	Approach	✓	✓	✓	✓	
	Day scene as required by 3 arc minutes resolution.				✓	✓	
d. Visual Scene Content							
(1) Aerodrome/Heliport Runways, Taxiways and TLOF	Demonstration model	Landing and Touchdown	✓	✓	✓	✓	For Tests (1) through (10) the demonstration models can be a sampling of specific models used in the operator's training programme or a generic heliport model. A minimum of three different types of database is required.
(2) Surfaces on Runways, Heliports, Taxiways and TLOF	Demonstration model	Ground or Flight	✓	✓	✓	✓	
d. (continued)							
(3) Lighting for the landing area in use	Demonstration model	Ground or Flight	✓	✓	✓	✓	All lights associated with the test landing area should be checked for appropriate colours and directionality (e.g. edge, centreline, touchdown zone, VASI, PAPI, REIL).
(4) Ramps and Terminal Buildings	Demonstration model	Ground			✓	✓	

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
(5) Dusk and Night Visual scene capability	Demonstration model	Flight	✓	✓	✓	✓	Dusk scene environment should include visible horizon and recognition of cultural features on the ground.
(6) General terrain characteristics and significant landmarks	Demonstration model	Flight		✓	✓	✓	Qualitative assessment.
(7) Capability to present Ground and Air Hazards such as another aircraft crossing the active runway or converging Airborne Traffic.	Demonstration model	Ground or Flight			✓	✓	Qualitative assessment.
(8) Operational visual scenes which portray representative physical relationships known to cause landing illusions on short runways, landing approaches over water, uphill or downhill runways, rising terrain on the approach path and unique topographic features.	Demonstration model	Landing and Touchdown				✓	May be a generic or specific airport/heliport model.
d. (continued)							
(9) Realistic colour and directionality of airport/heliport lighting	Demonstration model	Ground or Flight	✓	✓	✓	✓	
(10) Freedom from apparent quantization (aliasing).	Demonstration model	Cruise		✓	✓	✓	Sufficient scene details shall be provided to support cross-country navigation training at normal cruise speed.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
(11) Cross-country navigation	Demonstration model	Cruise		✓	✓	✓	Sufficient scene detail shall be provided to support cross-country navigation training at normal cruise speed.
e. Weather Effects							
(1) Special weather representations of light, medium, and heavy precipitation near a thunderstorm on takeoff, approach, and landings at and below an altitude of 610 m (2 000 ft) above the airport/heliport surface and within a radius of 16 km (10 sm) from the airport/heliport.	Demonstration model	Flight				✓	Qualitative assessment.
(2) Wet and snow covered landing areas including landing area lighting reflections for wet, partially obscured lights or snow or suitable alternative effects.	Demonstration model	Ground				✓	Qualitative assessment.
e. (continued)							
(3) Weather radar presentations in helicopters where radar information is presented on the pilot's navigation instruments. Radar returns should correlate with the visual scene.	Demonstration model	Flight			✓	✓	Qualitative assessment.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL A	LEVEL B	LEVEL C	LEVEL D	COMMENTS
(4) Variable cloud density	Demonstration model	Approach			✓	✓	Weather effects described in tests (4) through (8) should be selectable via controls at the instructor station such as cloud base, cloud effects, visibility and RVR. Visibility and cloud effects should be checked at and below an altitude of 610 m (2 000 ft) height above the airport/heliport and within a radius of 16 km (10 nm).
(5) Partial obscuration of surface scenes: the effect of a scattered to broken cloud deck.	Demonstration model	Approach			✓	✓	
(6) Visual cues of speed through clouds.	Demonstration model	Flight				✓	
(7) Gradual break out.	Demonstration model	Approach			✓	✓	
(8) Patchy fog.	Demonstration model	Approach or Take-off			✓	✓	
(9) The effect of fog on airport lighting.	Demonstration model	Approach or Take-off			✓	✓	
f. Flight Compatibility							
(1) Visual system compatibility with aerodynamic programming	Not applicable	Ground and Flight	✓	✓	✓	✓	Qualitative tests to verify the validity of Latency, throughput, and visual attitude versus simulator attitude tests.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
(2) Visual cues to assess sink rate and depth perception during landings.	Not Applicable	Approach and Landing		✓	✓	✓	Qualitative test to confirm that terrain features, surfaces on taxiways and ramps and other cultural features which provide cues for landing the helicopter.
(3) Dynamic visual representation of rotor tip path plane including effects of rotor start up and shut down as well as orientation of the rotor disc due to pilot control input.					✓	✓	
(4) To support LOFT, the visual system should provide smooth transition to new operational scenes without flight through clouds.						✓	
(5) The visual system should provide appropriate height and 3-D object collision detection feedback to support training.						✓	
(6) Accurate portrayal of environment relating to simulator attitudes.	Not Applicable	Flight	✓	✓	✓	✓	
f. (continued) (7) The effects for swell and wind on a 3 dimensional ocean model should be simulated.						✓	If required for specific training needs

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
(8) The effects of own helicopter downwash upon various surfaces such as snow, sand, dirt and grass should be simulated including associated effects of reduced visibility.						✓	
6. SIMULATOR SYSTEMS							
a. Visual, Motion, and Cockpit Instrument Response							
(1) Visual, Motion, Instrument System response to an abrupt pilot controller input, compared to helicopter response for a similar input.	150 milliseconds or less after helicopter response	Climb, Cruise, Descent	✓	✓			One test is required in each axis (pitch, roll. and yaw) for each of the 4 conditions (3 conditions, Levels A & B) compared to helicopter data for a simulator input. (Total 12 tests) (Total 9 tests, Levels A & B). Visual change may start before motion response, but motion acceleration must occur before completion of visual scan of first video field that contains different information.
	100 milliseconds or less after helicopter response	Climb, Cruise, Descent, Hover			✓	✓	
(2) Transport Delay	150 milliseconds or less after control movement.		✓	✓			One test is required in each axis. (Pitch, Roll, Yaw)
	100 milliseconds or less after control movement.				✓	✓	

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
b. Sound							
(1) Significant cockpit sounds which result from pilot actions corresponding to those of the helicopter.	Not Applicable	Flight and Ground	✓	✓	✓	✓	Statement of Compliance or Demonstration of representative sounds
(2) Sound of precipitation, windshield wipers, and significant cockpit sounds which include engines, transmission, rotors and other aircraft systems during normal operation as well as the sound resulting from a blade strike and a crash when operating the helicopter in excess of limitations.	Not Applicable	Flight and Ground			✓	✓	Statement of Compliance or Demonstration of representative sounds.
(3) Realistic amplitude and frequency of cockpit noises and sounds, including transmission, rotor, and airframe sounds.	TBD	On ground, all engines on. Hover. Straight and level flight at low speed. Straight and level flight at high speed. Steady turn at medium bank angle. Steady turn at high bank angle. Normal climb/descent.				✓	Test results should show a comparison of the amplitude and frequency content of the sounds that originate from the helicopter or helicopter systems. Sound data should be presented in one-third octave band or continuous frequency spectrum. The trend in amplitude and frequency of the aircraft data should be followed.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL				COMMENTS
			A	B	C	D	
c. Diagnostic Testing							
(1) A means for quickly and effectively testing simulator programming and hardware. This could include an automated system which could be used for conducting at least a portion of the tests in the QTG.					✓	✓	
(2) Self testing of simulator hardware and programming.						✓	

3.4 Information for Validation Tests

3.4.1 Control dynamics

3.4.1.1 The following points and methods of measurement should be considered:

(a) The characteristics of a helicopter flight control system have a major effect on handling qualities. A significant consideration in pilot acceptability of a helicopter is the "feel" provided through the cockpit controls. Considerable effort is expended on helicopter feel system design in order to deliver a system with which pilots will be comfortable and consider the helicopter desirable to fly. In order for a simulator to be representative of the helicopter, it too should present the pilot with realistic static and dynamic feel characteristics of the controls. Compliance with this requirement should be determined by comparing a recording of the control feel dynamics of the simulator to helicopter measurements in the takeoff, cruise, and landing configurations.

(b) 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, it is only possible to estimate the dynamic properties as a result of only being able to estimate true inputs and responses. Therefore, it is imperative that the best possible data be collected since close matching of the simulator control loading system to the helicopter systems is essential. The required control dynamics tests are indicated in Paragraph 3.3.2.a.(5).

(c) For initial and upgrade evaluations, it is required that control dynamics characteristics be measured at and recorded directly from the cockpit 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 takeoff, cruise, and landing flight conditions and configurations.

(d) For helicopters with irreversible control systems, measurements may be obtained on the ground if proper pitot-static inputs (if applicable) are provided to represent airspeeds typical of those encountered in flight. Likewise, it may be shown that for some helicopters, hover, climb, cruise and autorotation may have like effects. Thus, one may suffice for another. If either or both considerations apply, engineering validation or helicopter manufacturer rationale should be submitted as justification for ground tests or for eliminating a configuration. For simulators requiring static and dynamic tests at the controls, special test fixtures will not be required during initial and Upgrade evaluations if the STD operator's QTG 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.

3.4.1.2 Control dynamics evaluation.

The dynamic properties of control systems are often stated in terms of frequency, Damping, and a number of other classical measurements which can be found in texts on control systems. In order to establish a consistent means of validating test results for 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 both underdamped, and critically 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.

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

a. Underdamped response.

i Two measurements are required for the period, the time to first zero crossing (in case a rate limit is present) and the subsequent frequency of oscillation. It is necessary to measure cycles on an individual basis in case there are non-uniform periods in the response. Each period will be independently compared with the respective period of the helicopter control system and, consequently, will enjoy the full tolerance specified for that period.

ii The Damping tolerance should be applied to overshoots on an individual basis. Care should be taken when applying the tolerance to small overshoots since the significance of such overshoots becomes questionable. Only those overshoots larger than 5% of the total initial displacement should be considered significant. The residual band, labelled $T(A_d)$ on Figure 1 is ± 5% of the initial displacement amplitude A_d from the steady state value of the oscillation. Oscillations within the residual band are considered insignificant. When comparing Simulator Data with helicopter data, the process should begin by overlaying or aligning the simulator and helicopter steady state values and then comparing amplitudes of oscillation peaks, the time of the first zero crossing, and individual periods of oscillation. The simulator should show the same number of significant overshoots to be within one when compared with the helicopter data. This procedure for evaluating the response is illustrated in Figure 1 below.

b. Critically damped and overdamped response

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

3.4.1.3 Tolerances

The following table summarizes 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, ± 20% of Subsequent Peaks
$T(A_d)$	± 5% of A_d = Residual Band
Overshoots	± 1

3.4.1.4 Alternate method for control dynamics

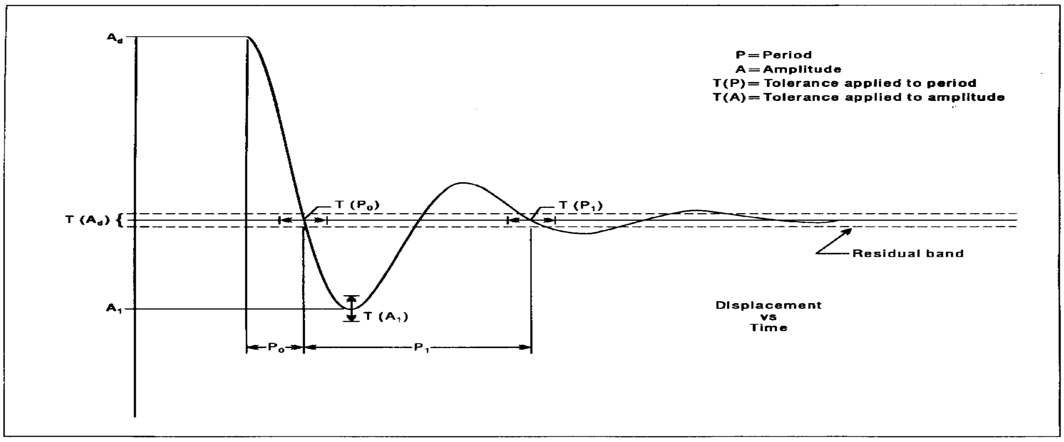


Figure 1 : Underdamped step response

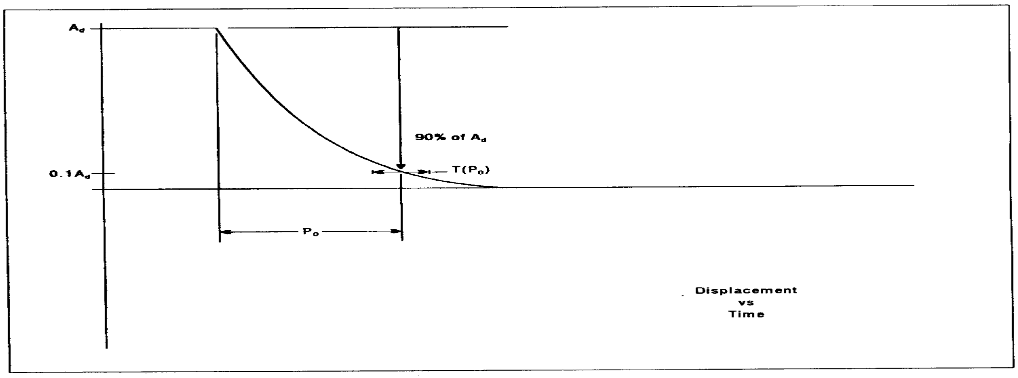


Figure 2 : Critically damped step response

One helicopter manufacturer has proposed, and the Authority has accepted, an alternate means for dealing with control dynamics. The method applies to helicopters 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.

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 taxi, takeoff, cruise, and landing conditions.

a. 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.

b. Slow dynamic test - Achieve a full sweep in approximately 10 seconds.

c. 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).

3.4.1.5 Tolerances

1. Static test - Items AMC STD 1H.030, paragraph 3.3 - 2.a (1) (2) and (3).

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

Note: 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 helicopters 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

3.4.2 Ground Effect

3.4.2.1 For a Flight Simulator to be used for lift-off and touchdown it should faithfully reproduce the aerodynamic changes which occur in Ground Effect. The parameters chosen for simulator validation should obviously be indicative of these changes. The primary validation parameters for characteristics in Ground Effect are:

a. Longitudinal, lateral, directional and collective control positions

b. Torque required for hover

c. Height

d. Airspeed

e. Pitch Attitude

f. Roll Attitude

3.4.2.2 This listing of parameters assumes that Ground Effect data is acquired by tests during hover at several heights in Ground Effect. The test heights should, as a minimum, be at 10%, 30%, and 70% of the helicopter rotor diameter and one height out of Ground Effect; e.g., 150% of rotor span.

3.4.2.3 The allowable parameter tolerances for validation of Ground Effect characteristics are:

a. Longitudinal. lateral, directional
and collective control positions ± 5%

b. Torque required for hover ± 5%

c. Height ± 10% or ± 1·5M (5 ft)

d. Airspeed ± 3 Kts

e. Pitch Attitude ± 1º

f. Roll Attitude ± 1º

3.4.3 Motion cue repeatability testing

The motion system characteristics in the table of Validation Tests address basic system capability, but not pilot cueing capability. Until there is an objective procedure for determination of the motion cues necessary to support pilot tasks and stimulate the pilot response which occurs in an aircraft for the same tasks, motion systems will continue to be “tuned” subjectively. Having tuned a motion system, however, it is important to demonstrate objectively that the system continues to perform as originally qualified. Any motion performance change from the initially qualified baseline can be measured objectively.

An objective assessment of motion performance change will be accomplished at least annually using the following testing procedure:

1) The current performance of the motion system should be assessed by comparison with the initial recorded data.

2) The parameters to be recorded should be the motion system drive algorithm acceleration command and the actual acceleration measured from the simulator accelerometers.

3) The test input signals should be inserted at an appropriate point prior to the integration in the equations of motion (see figure 3).

4) The characteristics of the test signal (see figure 4) should be set so that the acceleration command reaches 2/3 the motion system acceleration envelope as defined in section 4 a) for the linear axes. For the angular axes the velocity command should reach 2/3 of the angular velocity envelope as defined in section 4 a). The time T1 should be of sufficient duration to ensure steady initial conditions.

NOTE: If the simulator weight or C.G. changes for any reason, (i.e. visual system change, or structural change) then the motion system baseline performance repeatability tests should be rerun and the new results used for future comparison.

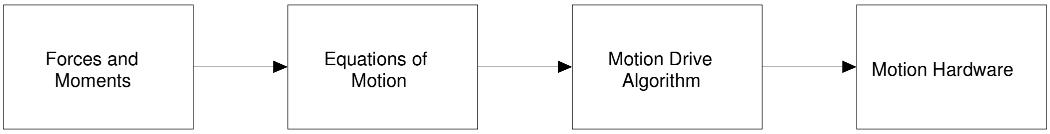


Figure 3

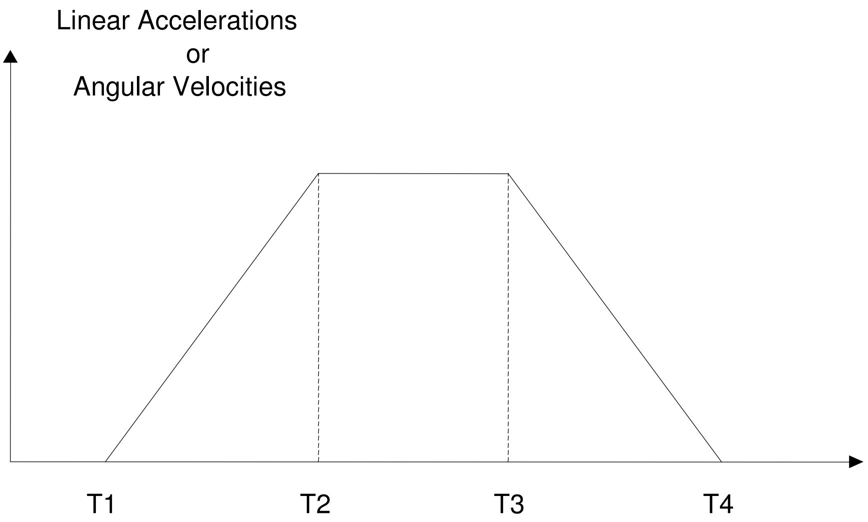


Figure 4

3.4.4 Visual systems

Daylight visual systems should meet the following criteria:

a) Contrast Ratio. A raster drawn test pattern filling the entire visual scene (three or more channels) should consist of a matrix of black and white squares no larger than 10 degrees and no smaller than 6 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.

Lightpoint contrast ratio should be not less than 25:1 when a square of at least 1 degree filled (i.e. lightpoint modulation is just discernible) with lightpoints are compared with the adjacent background.

b) Highlight Brightness Test. Maintaining the full test pattern described above, superimpose a highlight on the centre white square of each channel and measure the brightness using the 1 degree spot photometer. Lightpoints are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable.

c) Resolution will be demonstrated by a test of objects shown to occupy a visual angle of 3 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 - not greater than 6 arc minutes measured in a test pattern consisting of a single row of lightpoints reduced in length until modulation is just discernible, a row of 40 lights will form a 4 degree angle or less.

4. Functions and Subjective Tests

4.1 Discussion

4.1.1 Accurate replication of helicopter systems functions will be checked at each flight crew member position. This includes procedures using the STD operator's approved manuals, helicopter manufacturer’s approved manuals and checklists. Handling qualities, performance, and 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 co-ordinate 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.

4.1.2 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 helicopter. Unlike the Objective Tests listed in paragraph 3 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 are defined the minimum objective standards acceptable for that level. 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.)

4.1.3 At the request of the Authority, the simulator may be assessed for a special aspect of an STD 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 STD 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.

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

4.2 Test requirements

4.2.1 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.

4.2.2 Manoeuvres and procedures are included to address some features of advanced technology helicopters and innovative training programmes.

4.2.3 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.

4.2.4 When evaluating Functions and Subjective Tests, the fidelity of simulation required for the highest Level of Qualification should be very close to the aircraft. However, for the lower Levels of Qualification the degree of fidelity may be reduced in accordance with the criteria contained in paragraphs 2 and 3 above.

4.2.5 Any additional capability provided in excess of the minimum required standards for a particular Qualification Level should be assessed to ensure the absence of any negative impact on the intended training and testing manoeuvres.

4.3 Functions and manoeuvres

Note: Where a * (star) is used a check for the absence of negative effects is required. In the case of a check where objective data is available, STD operators are strongly recommended to document the baseline performance, thereby minimising the risk of differing subjective opinions during subsequent recurrent regulatory inspections.

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
a. PREPARATION OF FLIGHT				
(1) Preflight. Accomplish a functions check of all switches, indicators, systems and equipment at all cockpit crewmembers and instructors stations and determine that the cockpit design and functions are identical to that of the helicopter simulated.	✓	✓	✓	✓
b. SURFACE OPERATIONS				
(1) Engine start	✓	✓	✓	✓
(a) Normal start				
(b) Alternate start procedures				
(c) Abnormal starts and shutdowns (hot start, hung start, fire, etc.)				
(2) Rotor start/engagement and acceleration	✓	✓	✓	✓
(a) Ground resonance				
(3) Ground taxi	*	✓	✓	✓
(a) Power/cyclic input				
(b) Collective lever/cyclic friction				
(c) Ground handling				
(d) Brake operation				
(e) Tail-/nosewheel lock operation				
(f) Other				
c. HOVER				
(1) Liftoff	*	✓	✓	✓
(2) Instrument response	*	✓	✓	✓
(a) Engine instruments				
(b) Flight instruments				
(3) Hovering turns	*	*	✓	✓
(4) Hover power checks	*	✓	✓	✓
(a) In ground effect (IGE)				
(b) Out of ground effect (OGE)				
(5) Crosswind/tailwind hover	*	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
(6) Abnormal/emergency procedures:	*	✓	✓	✓
(a) Engine failure(s)				
(b) Fuel governing system failure				
(c) Hydraulic system failure				
(d) Stability system failure				
(e) Directional control malfunctions				
(f) Other				
(7) Antitorque effect	*	✓	✓	✓
d. AIR TAXI/TRANSIT				
(1) Forward	*	✓	✓	✓
(2) Sideways	*	✓	✓	✓
(3) Rearward	*	✓	✓	✓
e. TAKE-OFF				
(1) Cat.B or single engine helicopters				
(a) From hover	*	✓	✓	✓
(b) Running	*	✓	✓	✓
(c) Crosswind/tailwind	*	✓	✓	✓
(d) Maximum performance	*	✓	✓	✓
(e) Vertical	*	✓	✓	✓
(f) Slope	*	✓	✓	✓
(g) Elevated heliports	*	✓	✓	✓
(h) Engine failure during take-off	*	✓	✓	✓
(i) Forced landing	*	✓	✓	✓
(i) Land				
(ii) Water (with/without floats)				
(j) Other	*	✓	✓	✓
(2) Cat A operation for all certified profiles				
(a) Take-off with engine failure				
(i) engine failure prior to or at TDP	*	✓	✓	✓
(ii) engine failure at or after TDP	✓	✓	✓	✓
f. CLIMB				
(1) Cat.B or single engine helicopters				
(a) Clear area	✓	✓	✓	✓
(b) Obstacle clearance	✓	✓	✓	✓
(c) Vertical	*	✓	✓	✓
(d) Engine failure	✓	✓	✓	✓
(e) Other	✓	✓	✓	✓
f. (continued)				

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
(2) Cat.A operation for all certified profiles	✓	✓	✓	✓
(a) with engine failure up to 300m (1 000ft) above the level of the heliport				
g. CRUISE				
(1) Performance characteristics	✓	✓	✓	✓
(2) Flying qualities	✓	✓	✓	✓
(3) Turns	✓	✓	✓	✓
(a) Rate one/rate two				
(b) Steep				
(4) Accelerations and decelerations	✓	✓	✓	✓
(5) High airspeed vibrations	✓	✓	✓	✓
(6) Abnormal/emergency procedures	✓	✓	✓	✓
(a) Engine fire				
(b) Engine failure				
(c) Inflight engine shutdown and restart				
(d) Fuel governing system failures				
(e) Hydraulic failure				
(f) Stability system failure				
(g) Directional control malfunction				
(h) Rotor(s) vibrations				
(i) Other				
h. DESCENT				
(1) Normal	✓	✓	✓	✓
(2) Maximum rate	✓	✓	✓	✓
(3) Autorotative	*	✓	✓	✓
(a) Straight in				
(b) With turn				
(4) Other	✓	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
i. VISUAL APPROACHES				
(1) Cat.B or single engine helicopters				
(a) Approach	✓	✓	✓	✓
(i) Normal				
(ii) Steep				
(iii) Shallow				
(iv) Vertical				
(b) Abnormal/emergency procedures:				
(i) One engine inoperative	✓	✓	✓	✓
(ii) Fuel governing failure	✓	✓	✓	✓
(iii) Hydraulics failure	✓	✓	✓	✓
(iv) Stability system failure	✓	✓	✓	✓
(v) Directional control failure	✓	✓	✓	✓
(vi) Autorotation	*	✓	✓	✓
(vii) Other	✓	✓	✓	✓
(c) Balked landing	✓	✓	✓	✓
(i) All engines operating				
(ii) One or more engines inoperative				
(2) Cat.A operation for all certified profiles	✓	✓	✓	✓
(a) from 300m (1 000ft) above the level of the heliport to or after LDP				
j. INSTRUMENT APPROACHES				
(1) Non-precision	✓	✓	✓	✓
(a) All engines operating				
(b) One or more engines inoperative				
(c) Approach procedures:				
(i) NDB				
(ii) VOR/DME, RNAV				
(iii) ARA (Airborne radar approach)				
(iv) GPS				
(v) Other				
(d) Missed approach				
(i) All engines operating				
(ii) One or more engines inoperative				
(iii) Auto-pilot failure				

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
(2) Precision	✓	✓	✓	✓
(a) All engines operating				
(b) One or more engines inoperative				
(c) Approach procedures:				
(i) DGPS				
(ii) ILS				
- Manual				
- Flight director only				
- Auto pilot coupled				
- CAT I				
- CAT II				
(iv) Other				
(d) Missed approach				
(i) All engines operating				
(ii) One or more engines inoperative				
(iii) Auto pilot failure				
k. LANDING/TOUCHDOWN				
(1) Cat B or single engine helicopters				
(a) Normal				
(i) To a hover	*	✓	✓	✓
(ii) Running	*	✓	✓	✓
(iii) Elevated heliport/helideck	*	*	✓	✓
(iv) Slope	*	*	✓	✓
(v) Crosswind/tailwind	*	✓	✓	✓
(vi) Other	*	✓	✓	✓
(b) Touchdown				
(i) From a hover	*	✓	✓	✓
(c) Abnormal/emergency procedures				
(i) One engine inoperative	*	✓	✓	✓
(ii) Fuel governing failure	*	✓	✓	✓
(iii) Hydraulics failure	*	✓	✓	✓
(iv) Stability system failure	*	*	✓	✓
(v) Directional control failure	*	✓	✓	✓
(vi) Autorotation	*	✓	✓	✓
(vii) Other	*	✓	✓	✓
(2) Cat.A operation for all certified profiles	*	✓	✓	✓
(a) Landing with engine failure				
(i) engine failure prior to or at LDP				
(ii) engine failure at or after LDP				

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
l. ANY FLIGHT PHASE				
(1) Helicopter and powerplant systems operation	✓	✓	✓	✓
(a) Air conditioning				
(b) Anti-icing/de-icing				
(c) Auxiliary powerplant				
(d) Communications				
(e) Electrical				
(f) Lighting systems (internal and external)				
(g) Fire and smoke detection and suppression				
(h) Stabilizer				
(i) Flight controls/antitorque systems				
(j) Fuel and oil				
(k) Hydraulic				
(l) Landing gear				
(m) Powerplant				
(n) Transmission systems				
(o) Rotor systems				
(p) Flight control computers				
(q) Stability and control augmentation systems (SAS)				
(r) Voice activated systems				
(s) Other				
(2) Flight management and guidance systems	✓	✓	✓	✓
(a) Airborne radar				
(b) Automatic landing aids				
(c) Autopilot				
(d) Collision avoidance systems (GPWS, TCAS, ...)				
(e) Flight data displays				
(f) Flight management computers				
(g) Head-up displays				
(h) Navigation system				
(i) Other				
(3) Airborne procedures				
(a) Quickstop	*	*	✓	✓
(b) Holding pattern	✓	✓	✓	✓
(c) Hazard avoidance (GPWS, TCAS, Weather radar, ...)	*	*	✓	✓
(d) Retreating blade stall recovery	*	✓	✓	✓
(e) Rotor mast bumping	✓	✓	✓	✓
(f) Vortex ring	*	✓	✓	✓
(g) Other	✓	✓	✓	✓
m. ENGINE SHUTDOWN AND PARKING				
(1) Engine and systems operation	✓	✓	✓	✓
(2) Parking brake operation	✓	✓	✓	✓
(3) Rotor brake operation	✓	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
(4) Abnormal/emergency procedures	✓	✓	✓	✓
(5) Other	✓	✓	✓	✓
n. VISUAL SYSTEM				
(1) Accurate portrayal of environment relating to simulator attitudes and position.	✓	✓	✓	✓
(2) Airports				
(a) The distances at which airport features are visible should not be less than those listed below. Distances are measured from runway threshold to a helicopter aligned with the runway on an extended 3-degree glideslope.				
(i) Runway definition, strobe lights, approach lights, runway edge white lights and Visual Approach Aids from 8 km	✓	✓	✓	✓
(ii) Runway centreline lights and taxiway definition from 5 km	✓	✓	✓	✓
(iii) Threshold lights and touchdown zone lights from 3 km	✓	✓	✓	✓
(iv) Runway markings within range of landing lights for night scenes	✓	✓	✓	✓
(v) Runway markings as required by 3 arc-minute resolution on day scenes			✓	✓
(b) Representative airport scene content including the following:				
(i) Airport runways and taxiways	✓	✓	✓	✓
(ii) Runway definition				
(iii) Runway surface and markings				
(iv) Lighting for the runway in use, incl. runway edge and centreline lighting, touchdown zone, Visual Approach Aids and approach lighting of appropriate colours				
(v) Taxiway lights				
(3) Heliports				
(a) The distances at which heliport features are visible should not be less than those listed below. Distances are measured from the FATO centre to a helicopter aligned with the FATO approach direction on an extended 3-degree glideslope.				
(i) Heliport definition, strobe lights, approach lights from 8 km	✓	✓	✓	✓
(ii) Visual Approach Aids and FATO/TLOF edge lights should be visible from 5 km through approach angles up to 12 degrees	✓	✓	✓	✓
(iii) FATO/TLOF edge lights and taxiway definition from 3 km	✓	✓	✓	✓
(iv) FATO and TLOF markings within range of landing lights for night scenes	✓	✓	✓	✓
(v) FATO and TLOF markings as required by 3 arc-minute resolution on day scenes			✓	✓
n. (continued)				
(b) Representative heliport scene content including the following:	✓	✓	✓	✓
(i) Heliport definition				
(ii) Heliport surface				
(iii) Lighting for the FATO/TLOF, visual approach aids and approach lighting of appropriate colours				
(iv) Heliport perimeter lights				
(4) Operational helicopter lights.	*	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
(5) Instructor controls of the following: (a) Cloud base/cloud tops; (b) Visibility in kilometres/nautical miles and RVR in meters/feet; (c) Airport/heliport selection; (d) Airport/heliport lighting.	✓	✓	✓	✓
(6) Visual system compatibility with aerodynamic programming.	✓	✓	✓	✓
(7) Visual cues to assess sink rate displacements, rates and height AGL during landings (e.g. runways/heliports, taxiways, ramps and terrain features).	*	✓	✓	✓
(8) Both dusk and night visual scene capability.	✓	✓	✓	✓
(9) (a) At least three different heliport scenes which should be: (i) an area of not less than 800m open surface level; (ii) a surface level confined area; (iii) an elevated heliport.		✓	✓	✓
(b) The content of the scenes should cover:				
(i) Surfaces and markings on runways, heliport, taxiways and ramps;	✓	✓	✓	✓
(ii) Lighting of appropriate colour for all landing areas including runway edge, centreline, Visual Approach Aids and approach lighting for the runway in use;	✓	✓	✓	✓
(iii) Heliport perimeter and taxiway lighting;	✓	✓	✓	✓
(iv) Ramps and terminal buildings and vertical objects which correspond to the operational requirements of an operator's LOFT and Line Oriented Simulator scenario (LOS).			✓	✓
(10) General terrain characteristics. Below 5 000ft present realistic visual scene permitting navigation by sole reference to visual landmarks. Terrain altitude should be suitably represented.	*	✓	✓	✓
n. (continued)				
(11) At and below an altitude of 610 m (2 000 ft) height above the airport/heliport and within a radius of 16 kilometres (9 NM) from the airport/heliport, weather representations, including the following:				
(a) Variable cloud density			✓	✓
(b) Partial obscuration of ground scenes; the effect of a scattered to broken cloud deck			✓	✓
(c) Visual cues of speed through clouds				✓
(d) Gradual break out			✓	✓
(e) Patchy fog			✓	✓
(f) The effect of fog on airport/heliport lighting.			✓	✓
(12) A capability to present ground and air hazards such as another aircraft crossing the active runway and converging airborne traffic.			✓	✓
(13) Operational visual scenes which provide a cue rich environment sufficient for precise low airspeed/low altitude manoeuvring and landing.			✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
(14) Operational visual scenes which portray representative physical relationships known to cause landing illusions such as short runways, landing approaches over water, uphill, downhill and sloping landing areas, rising terrain on the approach path, and unique topographic features.				✓
(15) Special weather representations of light, medium, heavy precipitation and lightning near a thunderstorm on takeoff, approach and landing at and below an altitude of 610 m (2 000 feet) above the airport/heliport surface and within a radius of 16 kilometres (9NM) from the airport/heliport.				✓
(16) Wet and snow-covered landing areas including runway/heliport lighting reflections for wet, partially obscured lights for snow or suitable alternative effects.				✓ ✓
(17) The effects of swell and wind on a 3 dimensional ocean model should be simulated.				✓
(18) The effects of own helicopter downwash upon various surfaces such as snow, sand, dirt and grass should be simulated including associated effects of reduced visibility.				✓
(19) Realistic colour and directionality of airport/heliport lighting.	✓	✓	✓	✓
(20) Weather radar presentations in helicopters where radar information is presented on the pilot's navigation instruments. Radar returns should correlate to the visual scene.			✓	✓
(21) Dynamic visual representation of rotor tip path plane including effects of rotor start up and shut down as well as orientation of the rotor disc due to pilot control input.			✓	✓
(22) Freedom from apparent quantization (aliasing)	✓	✓	✓	✓
n. (continued)				
(23) To support LOFT, the visual system should provide smooth transition to new operational scenes without flight through clouds.				✓
(24) The visual system should provide appropriate height and 3-D object collision detection feedback to support training.				✓
o. SPECIAL EFFECTS				
(1) Runway rumble, oleo deflections, effects of groundspeed and uneven surface characteristics	*	✓	✓	✓
(2) Buffet due to translational lift	*	✓	✓	✓
(3) Buffet during extension and retraction of landing gear	*	✓	✓	✓
(4) Buffet due to high speed and retreating blade stall	*	✓	✓	✓
(5) Buffet due to vortex ring	*	✓	✓	✓
(6) Representative cues resulting from touchdown	*	✓	✓	✓
(7) Rotor(s) vibrations	✓	✓	✓	✓
(8) Translational lift	*	✓	✓	✓
(9) Antitorque device ineffectiveness	*	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	SIMULATOR LEVEL			
	A	B	C	D
(10) Significant helicopter noises should include engine, rotor, transmission, landing gear and other airframe sounds to a comparable level found in a helicopter. The sound of a crash should be related in a logical manner to landing in an unusual attitude or in excess of structural limitations of the helicopter.	✓	✓	✓	✓
(11) Effects of icing (a) airframe (b) rotors	*	*	✓	✓
(12) Effects of rotor contamination			✓	✓

IEM STD 1H.030 Level 'A' Flight Simulators
See YCAR-STD 1H.030

1 Background

1.1 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.

1.2 Although YCAR-STD recognises the criteria for Level 'A' Simulators described in FAA AC 120-63, 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 Simulators for the smaller helicopter used by the general aviation community.

1.3 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.

Note: To attempt to reduce the cost of ownership of a JAA Level A Flight Simulator, each element has been examined in turn and with a view to relaxing the requirements where possible whilst recognising the training, checking and testing credits allowed on such a device.

2 Data package

The cost of collecting specific Flight Test Data sufficient to provide a complete model of the aerodynamics, engines and flight controls can be significant. In the absence of type specific data packages the use of a class specific data package which could be tailored to represent a specific type of helicopter is acceptable. 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 helicopters. Such work including justification and the rationale for the changes would have to be carefully documented and made available for inspection by the YCAR-STD Working Group 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.

The use of CT&M is not to be taken as a indication that certain areas of simulation can be ignored. Indeed in the class of helicopter 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 helicopter 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 in no way 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 in no way providing 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’ day light 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 A single channel direct viewing system would be acceptable for this level of Flight Simulator.

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

(a) at the CAT 1 all weather operations decision height, the appropriate visual ground segment may not be "seen", and

(b) during an approach, where the helicopter 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 helicopters 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 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 Aircraft parts

As with any level of Flight Simulator, the components used within the cockpit area need not be helicopter 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, feel and have the same functionality as in the helicopter.

IEM to AMC STD 1H.030, para 2.1 Rotor Aerodynamic Modelling Techniques
See AMC STD 1H.030, para 2.1

1. Introduction

Several modelling choices are available to simulate rotor blade aerodynamics. These include rotor disks, rotor maps, and blade element rotor models. Cost, simulation fidelity, and training requirements are three factors that may determine the appropriate model to use.

2. Disk models

2.1 Rotor disk models typically approximate blade flapping by the first few terms of a Fourier series. The lift curve is assumed to be a linear function of angle of attack and inflow is usually assumed to be uniform over the entire disk. With these assumptions the forces and moments produced by the blades over the course of one complete revolution can be written analytically. Blade azimuthal position can then be ignored by the rest of the helicopter aerodynamic model which sees normalized forces as generated by a thrust producing disk. Disk models are usually easy to implement and tune, and require minimal computer resources to run. Disk models are best at matching static performance characteristics, and weakest in matching dynamic handling qualities and flight at extremes of the flight envelope where some of the underlying assumptions cease to be true. The risk is that these models may require an unmanageable accumulation of add-ons to simulate all the helicopter effects that do not flow naturally out of the model such as blade stall, dynamic stall, reverse flow, and cross coupling effects. For certain helicopter types, and for many tail rotors, some of these effects will be negligible or occur outside of the civil flight envelope and thus not impact the training requirements of the Flight Simulator. Adding the effects of sharp wind gradients over the rotor disk, that may occur in confined areas or in pinnacle training is problematic as the formulation assumes constant wind speed over the disk.

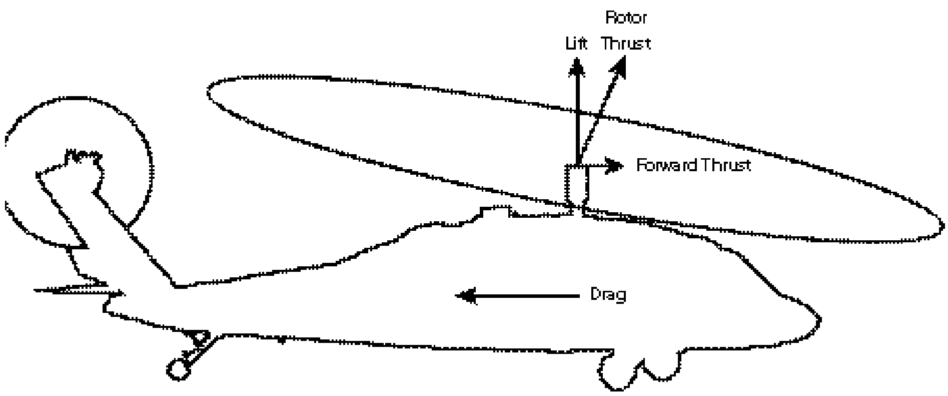


Figure 1

3. Rotor map models

3.1 Rotor map models, or coefficient models, are also not computationally demanding. In this method a database of coefficients or stability and control derivatives is used to compute aircraft forces and moments. The simulation will interpolate its performance from the nearest points in the database. This data base can be generated from flight test data analysis or from an off-line blade element model. Steady state performance can in theory, be easily tuned by simply adjusting data points in the database. However if the database is generated from an off-line model blade element model then considerable effort could be spent tuning the off-line model that is one step removed from the simulation. The net result is a saving in real time execution, but development costs may be as high as a full blade element model. The blade element model that generates the database, since it runs off-line, is not limited by real time constraints and thus can be considerably more complex than real time blade element models. Flight Simulator fidelity may be limited by the overall size and coarseness of the database. Not every flight possibility will be covered by the database and separate databases may need to be generated to simulate failure modes. As with the rotor disk model the incorporation of known air flows into the simulation at the blade elements is problematic and could effect for example, the realism of simulated turbulence, and the effectiveness of confined area landing training where the winds have large gradients such that they will not be constant over the entire rotor disk.

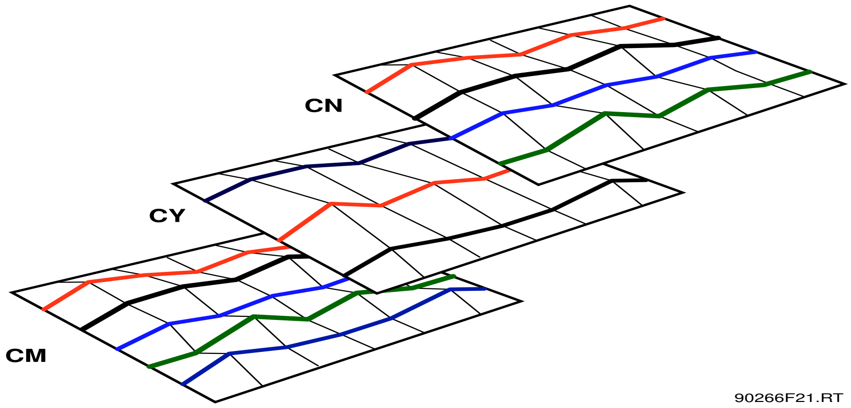


Figure 2

4. Blade Element Rotor Models

4.1 A blade element rotor model, has at its core a division of the blade into discrete segments. Rotor speed and radial station as well as local winds at each segment are used to compute local angle of attack, sideslip and mach number. Using the airfoil characteristics of airfoil at the blade segment aerodynamic forces are computed. Once all the forces and moments for all segments have been computed the equations of motion of each blade are solved. Real time constraints may limit the number of segments, and the degrees of freedom/flexibility of the blades and the complexity of the inflow model. A real time blade element model, and its associated inflow model is significantly more complex than a rotor disk, but offers a more rigorous simulation of a helicopter rotor blade dynamics. Blade motions even at very low rotor speeds are computed in the same manner, thus offering fidelity simulation of helicopter operations from rotor stopped, through startup, to the full flight envelope including malfunctions and the effects of sharp wind gradients across the blade elements that occur in confined areas or in pinnacle training. The model can be used to provide helicopter vibrations amplitudes and trends.

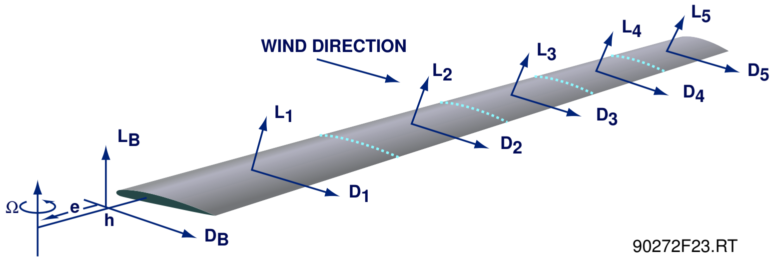


Figure 3

5.

5.1 The modelling choice alone, cannot ensure fidelity. The best guarantor of accurate simulation training remains validation with flight test data. A blade element rotor model reduces risk to simulation training by giving a more comprehensive rotor simulation, but comes at a price of increased complexity and computer resource requirements. This may be warranted where the training objectives of the simulation require a very high level of fidelity.

IEM TO AMC STD 1H.030, para 2.2 Vibration Platforms for Helicopter Flight Simulators
See AMC STD 1H.030, para 2.2

1 The role of vibrations in pilot cueing

1.1 Motion feedback in rotary wing aircraft has a wide bandwidth of frequencies and amplitudes consisting of cues ranging from large sustained accelerations up to high frequency vibrations generated by the rotor harmonics. Vibrations on helicopters, in addition to creating a harsh operating environment, provide pilots with rotor dynamic feedback critical to his/her ability to control the aircraft. Normal and abnormal flying conditions are therefore sensed by the pilots through the vibration levels/amplitudes and are integral to helicopter flying. Rotor malfunctions/conditions such as icing or damage are rapidly identified subjectively by sensing the increased vibration levels and change in characteristics.

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

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

2 Limitations of using a 6 Degree-of-Freedom motion system to reproduce vibrations

2.1 The simulation of vibration cues for rotary wing aircraft as produced by a conventional six-degree-of-freedom (6-DOF) motion system is limited. While most motion systems are capable of reproducing vibrations, the dynamic range of helicopter vibration amplitudes and frequencies (3 Hz to 50 Hz, typically) exceed the limited bandwidth capability of synergistic motion systems (typically 0 Hz to 10 Hz in the vertical axis and lower in the longitudinal and lateral axes).

2.2 Moreover, the application of representative vibrations to the entire simulator structure may adversely impact the life span of some simulator components such as the visual system.

3 Advantages of a dedicated 3 Degree-of-Freedom vibration platform

3.1 To augment the performance of a 6 DOF motion system and achieve accurate reproduction of vibrations while minimizing stresses on the simulator structure, it is proposed that the motion cueing frequency bandwidth be separated in two. Dedicated cueing devices would then be assigned to reproduce each specific frequency range. The lower frequency range is used to drive the motion system and the higher frequency range, with the majority of the vibration information, is used to drive the vibration platform.

2 Two solutions may be used for simulating the vibrations:

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

(b) A vibration platform consisting of a 3 degree of freedom system to make the seats, the controls and the main instrument board vibrate independently from the cockpit. This solution decreases the moving mass relatively to the payload and therefore minimizes the risk of resonance.

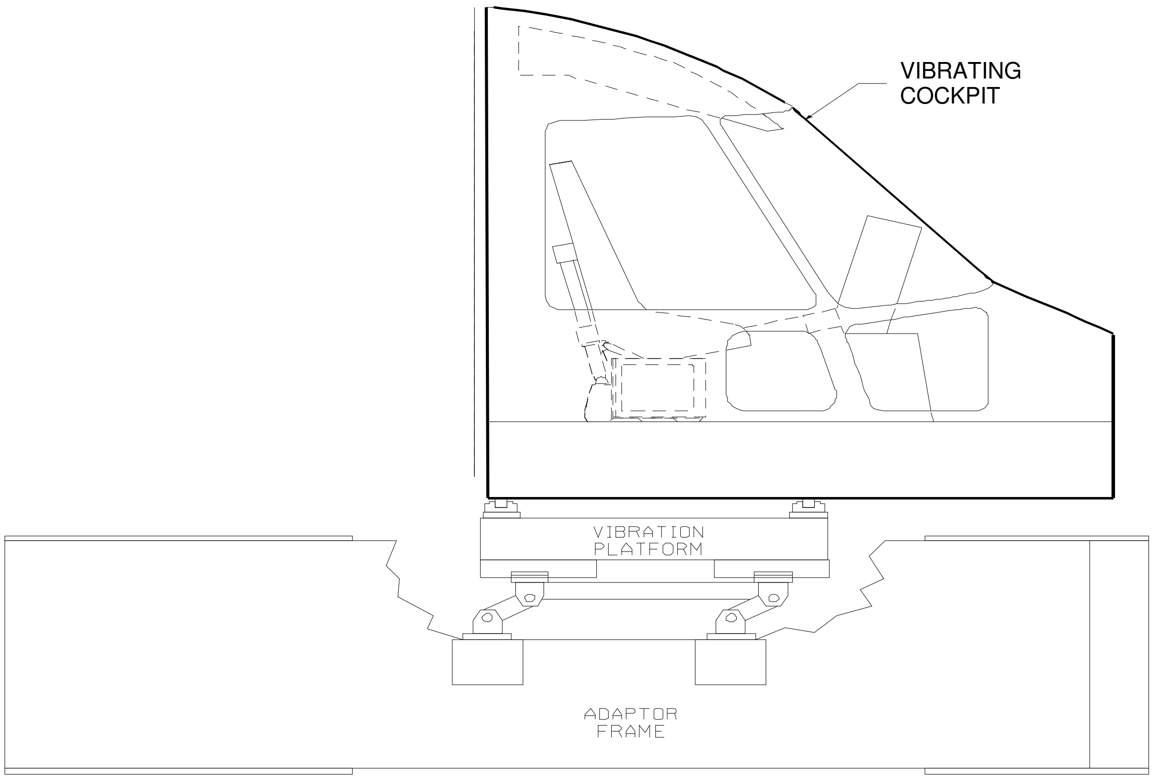


Figure 1: An Example of a three degree of freedom cockpit vibration system

IEM to AMC STD 1H.030, para 2.3 Visual Display Systems
See AMC STD 1H.030, para 2.3

1. Introduction

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

2. Basic principles of a Flight Simulator collimated display

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

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

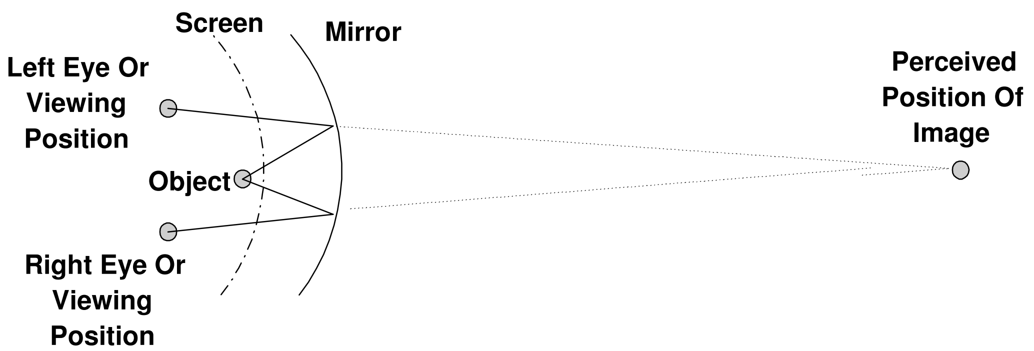


Figure 1 - Collimated display

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

2.4 While the horizontal Field of View (FOV) of a collimated display can be extended to approximately 210-220 degrees, the vertical FOV has normally been limited to about 40-45 degrees. These limitations result from tradeoffs in optical quality as well as interference between the display components and cockpit structures, but were sufficient to meet Flight Simulator regulatory approval for aeroplane Flight Simulators. More recently designs have been introduced with vertical FOVs of up to 60 degrees for helicopter applications.

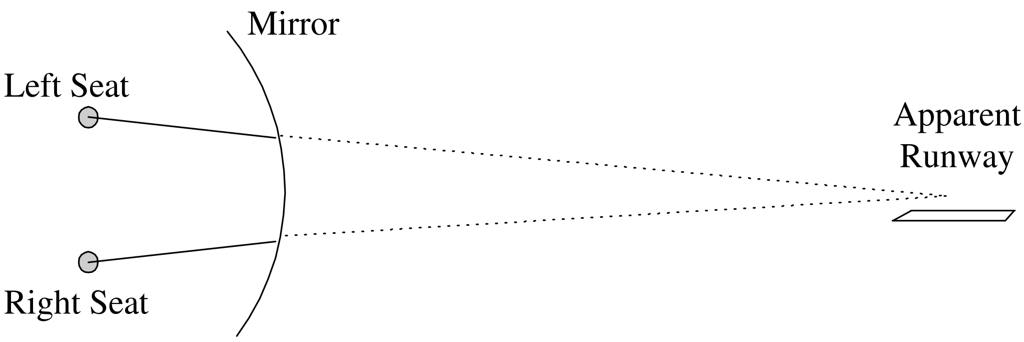


Figure 2 - Runway view in a collimated display

3. Basic principles of a Flight Simulator dome display

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

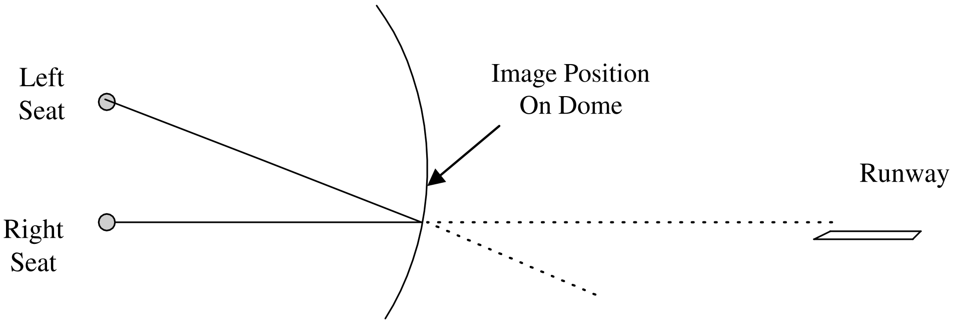


Figure 3 - Runway view in a dome display

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

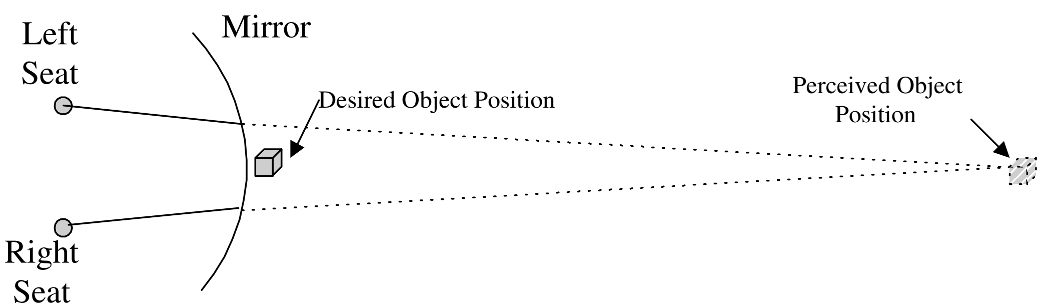


Figure 4 – Near field object in a collimated display

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

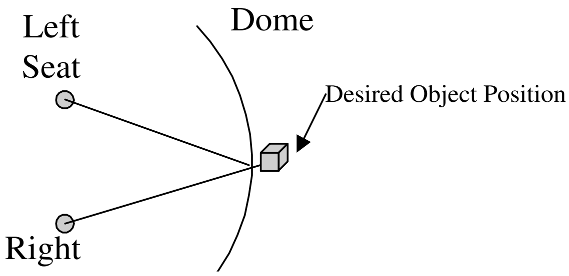


Figure 5 – Near field object in a dome display

4. Additional display considerations

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

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

5. Training implications

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

AMC STD 1H.035 Flight Simulators Approved or Qualified before 1 January 2005
See YCAR-STD 1H.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 1H.

2 Recategorisation
Some of these Flight Simulators may be of a standard which permits them to be recategorised as if they were Flight Simulators presented for initial qualification on or 1 January 2005.

3 Equivalent categories AG, BG, CG, DG

3.1 Flight Simulators that are not recategorised 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 the Appendix to YCAR-STD 1H.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 following table describes the relationship :

QUALIFICATION LEVEL - FLIGHT SIMULATORS QUALIFIED OR APPROVED BEFORE 1 JANUARY 2005		QUALIFICATION LEVEL - FLIGHT SIMULATORS QUALIFIED ON OR 1 JANUARY 2005
A G	Similar maximum credits for	A
B G	Similar maximum credits for	B
C G	Similar maximum credits for	C
D G	Similar maximum credits for	D

Note: 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 Level of Qualification is given. The minimum acceptable standard is FAA AC 120-63 or equivalent.

4 Original national qualification

4.1 Flight Simulators that are not recategorised 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 and Functions and Subjective Tests which have been previously established or a list of tests selected from AMC STD 1H.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 a 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 January 2005 and which are not recategorised :

	EQUIVALENT QUALIFICATION LEVEL	PERFORMANCE CRITERIA
Primary Ref. Doc	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 Primary Ref. Doc	<u>Special Categories</u> Unique list of Manoeuvres	Original Validation, Functions and Subjective Tests or a list of tests selected from AMC STD 1H.030 (by agreement)

AMC STD 1H.045 New Helicopter Flight Simulator Qualification
See IEM STD 1H.045

(a) During the introduction of new helicopter programmes, it is not always possible to obtain all the necessary data and certified helicopter avionics in time to satisfy the requirements for normal Flight Simulator Qualification. The Authority may accept a measure of engineering and predicted data as well as preliminary avionics for a limited period to enable crew training to begin without delay.

(b) STD operators seeking interim qualification should contact the Authority at the earliest opportunity.

IEM STD 1H.045 New Helicopter Flight Simulator Qualification - Additional Information
See YCAR-STD 1H.045

1 It is usual that helicopter manufacturers' approved final data for performance, handling qualities, systems, or avionics will not be available until well after a developmental helicopter enters service. It is, of course, necessary in most cases to begin flight crew training and certification several months prior to the first entry of the helicopter into service in order to have qualified crew members in sufficient numbers at the time of the beginning of service with the new helicopter. Consequently, it may be necessary to use helicopter manufacturer provided preliminary data (performance, handling qualities, systems, avionics) 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 helicopter 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. The helicopter and Flight Simulator manufacturers should also be made aware of these requirements and be an agreed party to the data development and Flight Simulator qualification plan. The plan should include periodic meetings to keep the interested parties informed of project status.

4 The precise procedure followed to gain Authority acceptance of preliminary data will vary from case to case and between helicopter manufacturers. Each helicopter manufacturer's new helicopter 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 helicopter. Hence, there cannot be a prescribed invariable procedure for acceptance of preliminary data, but instead a statement of needs with the final sequence of events, data sources, and validation procedures agreed by the STD operator, the helicopter manufacturer, the Flight Simulator manufacturer, and the Authority.

5 There should be assurance that the preliminary data is the manufacturer's best representation of the helicopter and that the 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) A manufacturer's engineering report explaining the predictive method used and illustrating past success of the method on similar projects should be provided. For example, the manufacturer could show the application of the method to an earlier helicopter model or predict the characteristics of an earlier model and compare the results to final data for that model.

(b) Early flight tests data will often be derived from helicopter 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 helicopter 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 a helicopter failure mode including engine failures. The early data available will, however, depend on the helicopter 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 helicopter 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 helicopter manufacturer's final data should be available within six (6) months after helicopter's first "service entry" or as agreed by the Authority, the STD operator and the helicopter manufacturer, but usually not later than one (1) year. In applying for an interim qualification, using preliminary data, the STD operator and the Authority should agree to the update programme. This will normally specify that the final data update will be installed in the Flight Simulator within a period of six (6) months following the final data release unless special conditions exist and a different schedule is agreed. The Flight Simulator performance and handling validation would then be based on data derived from flight test. Initial helicopter systems data should be updated after engineering tests. Final helicopter systems data should also be used for Flight Simulator programming and validation.

7 Flight Simulator avionics should stay essentially in step with helicopter avionics (hardware & software) updates. The permitted time lapse between helicopter 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 helicopter 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 helicopter Predicted Data, and Flight Test Data. For data collected from specific helicopter 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 helicopter manufacturer.

b. In order that the two sets of data are properly validated, the supplier of approved data should compare their simulation model responses, based on the implementation of the same design data released to the Flight Simulator manufacturers, against the Flight Test Data, and be 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.

i. Propulsion

ii. Aerodynamics

iii. Mass Properties

iv. Flight Controls

v. Stability Augmentation

vi. Brakes/Landing Gear

9 For the qualification of Flight Simulators of new helicopter 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 AMC STD 1H.030 tolerances.