HONG KONG
CIVIL AVIATION DEPARTMENT

CAD 453(H)

FLIGHT SIMULATOR QUALIFICATIONS (HELICOPTER)

FSQ(H)
2nd Edition
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RECORD OF AMENDMENTS

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2nd Edition Issue 1	**14 April 2021**	*******

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FOREWORD

I. Flight Simulation Training Devices (FSTDs) utilised by Hong Kong flight crew licence holders within Hong Kong SAR or overseas, must be approved or accepted by the Hong Kong Civil Aviation Department (CAD) to the operational standards and requirements listed in this publication before credits, training and/or testing conducted utilising such FSTDs will be recognised by CAD.

II. CAD, may grant approval for FSTD credits as a result of compliance with this publication and the degree of realism found to exist. The approval/acceptance will also be dependent upon the applicant's training and checking organisation being approved to conduct training and checking in the nominated FSTDs.

III. No approved training sequence in a FSTD can be used as a credit towards a flight crew flight proficiency test or experience credit until such time as the FSTD has satisfactorily completed an accreditation check by a suitably qualified inspector of CAD to ensure suitability for intended use.

IV. An accreditation check must be performed by CAD, prior to CAD assigning the FSTD a level of accreditation. It is a requirement that approved FSTDs maintain the performance, functional and other characteristics that were required for the accreditation. Ongoing approval of the FSTD is conditional upon recurrent checks demonstrating the continued fidelity of the FSTD at regular intervals after initial accreditation.

V. Various Acceptable Means of Compliance (AMCs) are presented by the worldwide authorities oversighting FSTD use and accreditation, (eg ICAO 9625 – Manual of Criteria for the qualification of FSTD's/EASA CS-FSTD(H) initial issue, FAA Part 60). These various AMC standards may be used as applicable. Final assessment/approval for the particular FSTD use will only be given by CAD.

VI. The policy concerning the accreditation and fidelity checking of overseas flight simulators is the same as the requirements for FSTDs located in the Hong Kong SAR.

VII. It is to be noted that this Document is a complete reissue of the previous CAD 453, updating it to current standards. Therefore no vertical amendment highlight bars are to be found.

Note: Most FSTDs within Hong Kong SAR, if not all, are in the Full Flight Simulator category. For clarity, FSTD official documents may be referred to as 'FLIGHT SIMULATOR APPROVAL' .

CONTENTS

CHAPTER 1 INTRODUCTION

1. Purpose

1.1 The Air Navigation (Hong Kong) Order 1995 (the Order) provides for the use of flight simulators approved by the Civil Aviation Department (CAD) for some of the training and tests of competency called for under the provisions of the Order. The purpose of this document is to establish the standards which define the performance and documentation requirements for the evaluation of helicopter flight simulators used for training of flight crew members, and for the conduct of flying tests called for in Schedule 9 & 11 to the Order.

2. Background

2.1 The availability of advanced technology has permitted greater use of flight simulators for training 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 with assurance that the observed behavior will transfer to the helicopter. Fuel conservation and reduction in adverse environmental effects are important by-products of flight simulator use.

3. Applicability

3.1 Pursuant to Schedule 9 and Schedule 11 to the Air Navigation (Hong Kong) Order 1995, the use of flight simulator [or Flight Simulation Training Device (FSTD)] for the purpose of tests shall be approved by the HKCAD. CAD 453(H) applies to FSTD operators seeking qualification of any FSTD for the abovementioned purpose. The FSTD may be used only under the supervision of an appointed competent person approved for the purpose.
Although this document provides some general guidance material for FSTD users, it should be again noted that there are various oversighting agencies supplying Acceptable Means of Compliance information (e.g. ICAO ,EASA,FAA), which may be consulted during the application or renewal process. Final acceptance of any utilized AMC guidance remains with this Department. Furthermore, for clarity, precise details of any credit/training/check approvals are contained in the 'Schedule' to the FSTD Approval Document issued by this Department.

4. Paragraph numbering

4.1 A non-standard paragraph numbering system has been adopted in some of the Appendices to facilitate tabularization.

5. Amendments

5.1 Amendments to this document will be forwarded to all operators of flight simulators approved under these arrangements. Additional copies of the document, and amendments, are available from the Civil Aviation Department.

6. Terminology

6.1 Because of the technical complexity of flight simulator training device qualification, it is essential that standard terminology is used throughout. The following principal terms and abbreviations must be used in order to comply with CAD 453(H). Further definitions and abbreviations are contained in the Glossary of Terms and Abbreviations.

***Flight Simulation Training Device* (*FSTD*).** A training device which is: In the case of airplanes, a full flight simulator (FFS), a flight training device (FTD), a flight navigation procedures trainer (FNPT), or a basic instrument training device (BITD). In the case of helicopters, a full flight simulator (FFS), a flight training device (FTD) or a flight navigation procedures trainer (FNPT).

Full Flight Simulator (FFS). 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 FFS qualification. The terminology can be used interchangeably with *Flight Simulator* in this document.

***Flight Training Device* (*FTD*).** A full size replica of a specific aircraft type.s instruments, equipment, panels and controls in an open flight deck/cockpit area or an enclosed aircraft flight deck/cockpit, including the assemblage of equipment and computer software programmes necessary to represent the aircraft 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.

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

Other training device (OTD). Means a training aid other than an FSTD which provides for training where a complete flight deck/cockpit environment is not necessary

***Flight Simulator Approval (FSTD Approval*).** The extent to which a simulator of a specified qualification level may be used by persons, organisations or enterprises as approved by the Department. It takes account of helicopter to simulator differences and the operating and training ability of the organisation. The terminology can be used interchangeably with *Simulator Approval* in this document

Flight Simulator Operator (FSTD Operator). That person, organisation or enterprise directly responsible to the Department for requesting and maintaining the qualification of a particular flight simulator. The terminology can be used interchangeably with *Simulator Operator* in this document.

Flight Simulator Training Device User (FSTD User). The person, organisation or enterprise requesting training and checking credits through the use of a flight simulator. The terminology can be used interchangeably with *Simulator User* in this document.

Flight Simulator Training Device Qualification (FSTD Qualification). The level of technical ability of an FSTD as defined in the compliance document. The terminology can be used interchangeably with *Simulator Qualification* in this document.

Qualification Test Guide (QTG). A document designed to demonstrate that the performance and handling qualities of an FSTD are within prescribed limits with those of the aircraft, class of helicopter or type of helicopter and that all applicable requirements have been met. The QTG includes both the data of the aircraft, class of aeroplane or type of helicopter and FSTD data used to support the validation.

6.2 Glossary

In addition to the principal definitions, additional terms used in the context of CAD 453(H) have the following meanings:

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

Aircraft Performance Data. Performance data published by the aircraft manufacturer in documents such as the aircraft flight manual (AFM), operations manual, performance engineering manual, or equivalent.

Airspeed. Calibrated airspeed when relevant or other airspeed which is clearly annotated. Altitude. means pressure altitude when relevant or other altitude which is clearly annotated.

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

Automatic Testing. FSTD testing wherein all stimuli are under computer control.

Bank. The bank/roll angle (degrees).

Baseline. A fully flight test validated production aircraft simulation. May represent a new aircraft type or a major derivative.

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

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

Computer Controlled Aircraft. An aircraft where the pilot inputs to the control surfaces are transferred and augmented via computers.

Control Sweep. A movement of the appropriate pilot's control from neutral to an extreme limit in one direction (forward, aft, right, or left), a continuous movement back through neutral to the opposite extreme position, and then a return to the neutral position.

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

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

Damping (critical). 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.

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.

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.

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

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.

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

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

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

Engineering Simulator Data. Data generated by an engineering simulation or engineering simulator, depending on the aircraft manufacturer's processes.

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

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

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

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

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

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

FSTD Data. The various types of data used by the FSTD manufacturer and the applicant to design, manufacture, test and maintain the FSTD.

FSTD Evaluation. A detailed appraisal of an FSTD by the HK CAD to ascertain whether or not the standard required for a specified qualification level is met.

FSTD Operator. Organisation directly responsible to the HK CAD for requesting and maintaining the qualification of a particular FSTD.

Fuel used. The mass of fuel used (kilos or pounds).

Full Sweep. The movement of the controller from neutral to a stop, usually the aft or right stop, to the opposite stop and then to the neutral position.

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

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

Grandfather Rights. The right of an FSTD operator to retain the qualification level granted under a previous regulation of an EASA member state. Also the right of an FSTD user to retain the training and testing/checking credits which were gained under a previous regulation of an EASA Member State.

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

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

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

Heavy. With operational mass at or near maximum for the specified flight condition.

Height. The height above ground (AGL) (meters or feet)

Highlight Brightness. The maximum displayed brightness, which satisfies the appropriate brightness test.

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

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

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

Latency. The additional time beyond that of the basic perceivable response time of the aircraft due to the response time of the FSTD.

Light. With operational mass at or near minimum for the specified flight condition.

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

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

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

Medium. The normal operational weight for flight segment.

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

Nominal. The normal operational weight, configuration, speed etc. for the flight segment specified.

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

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

Normal Control. A term used in reference to computer controlled aircraft. Normal control is the state where the intended control, augmentation and protection functions are fully available.

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

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

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

Predicted Data. Data derived from sources other than type-specific aircraft flight tests.

Primary Reference Document. Any regulatory document which has been used by a HK CAD to support the initial evaluation of an FSTD.

Proof-of-Match (POM). A document that shows agreement within defined tolerances between model responses and flight test cases at identical test and atmospheric conditions.
Protection functions. means systems functions designed to protect an aircraft from exceeding its flight and manoeuvre limitations.

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

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

Robotic Test. A basic performance check of a systems hardware and software components. Exact test conditions are defined to allow for repeatability. The components are tested in their normal operational configuration and may be tested independently of other system components.

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

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

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

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

Throttle Lever Angle (TLA). The angle of the pilot's primary engine control lever(s) on the cockpit.

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

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

Twilight (dusk/dawn) Visual. A visual system capable of meeting, as a minimum, the system brightness and contrast ratio requirements and performance criteria appropriate for the level of qualification sought. The system, when used in training, should provide, as a minimum, full colour presentations of reduced ambient intensity (as compared with a daylight visual system), sufficient to conduct a visual approach, landing and airport movement (taxi).

Update. The improvement or enhancement of an FSTD.

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

Validation Data. Data used to prove that the FSTD performance corresponds to that of the aircraft, class of aeroplane or type of helicopter

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

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

Vibration. A permanent effect resulting from airframe interaction with rotor, engine or transmission, as opposed to buffet which is a transient vibration effect resulting from either pilot action or aerodynamic effect on the airframe.

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

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.

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

6.3 Abbreviations

A	Aeroplane
AC	Advisory Circular
ACJ	Advisory Circular Joint
A/C	Aircraft
Ad	Total initial displacement of pilot controller (initial displacement to final ADF = automatic direction finder resting amplitude)
AFM	Aircraft Flight Manual
AFCS	Automatic Flight Control System
AGL	Above Ground Level (metres or feet)
An	Sequential amplitude of overshoot after initial X axis crossing, e.g. A1 = 1st overshoot.
AEO	All Engines Operating
AOA	Angle of Attack (degrees)
ARA	Airborne Radar Approach
ATO	Approved Training Organisation
BC	ILS Localiser Back Course
CAT I/II/III	Landing Category Operations
CCA	Computer Controlled Aeroplane
CCH	Computer Controlled Helicopter
cd/m2	candela/metre2, 3·4263 candela/m2 = 1 ft-Lambert
CG	Centre of Gravity
cm(s)	centimetre, centimetres
CS	Certification Specifications
CT&M	Correct Trend and Magnitude
daN	decaNewtons
dB	decibel
deg(s)	degree, degrees
DGPS	Differential Global Positioning System
DH	Decision Height
DME	Distance Measuring Equipment
DPATO	Defined Point After Take-Off
DPBL	Define Point Before Landing
EPR	Engine Pressure Ratio
EW	Empty Weight
FAA	United States Federal Aviation Administration
FATO	Final Approach and Take-off

FD	Flight Director
FOV	Field of View
FPM	feet per minute
ft	feet, 1 foot = 0·304801 metres
ft-Lambert	foot-Lambert, 1 ft-Lambert = 3·4263 candela/m2
g	acceleration due to gravity (m or ft/s2), 1g = 9·81 m/s2 or 32·2 ft/s2
G/S	glideslope
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
H	Helicopter
HGS	Head-up Guidance System
HSI	Horizontal Situation Indicator
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IGE	In Ground Effect
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
in	inches, 1 in = 2·54 cm
IOS	Instructor Operating Station
IPOM	Integrated Proof of Match
IQTG	International Qualification Test Guide (RAeS Document)
km	kilometres, 1 km = 0·62137 statute miles
kPa	kiloPascal (kiloNewton/metres2). 1 psi = 6·89476 kPa
kts	knots calibrated airspeed unless otherwise specified, 1 knot = 0·5148 m/s or 1·689 ft/s
lb	pounds
LOC	localiser
LOFT	Line Oriented Flight Training
LOS	Line Oriented Simulation
LDP	Landing Decision Point
m	metres, 1 metre = 3.28083 ft
MCC	Multi-Crew Cooperation
MCTM	Maximum Certificated Take-off Mass (kilos/pounds)
MEH	Multi-Engined Helicopter
min	minutes
MLG	Main Landing Gear
mm	millimetres
MPa	megaPascals, 1 psi = 6894·76 pascals
MQTG	Master Qualification Test Guide
ms	millisecond(s)
MTOW	Maximum Take-off Weight
n	Sequential period of a full cycle of oscillation
N	NORMAL CONTROL Used in reference to computer controlled aircraft
N/A	Not Applicable
N1	Engine low pressure rotor revolutions per minute expressed in percent of maximum
N1/Ng	gas generator speed
N2	Engine high pressure rotor revolutions per minute expressed in percent of maximum
N2/Nf	free turbine speed
NDB	Non-Directional Beacon
NM	nautical mile, 1 nautical mile = 6 080 ft = 1 852 m
NN	non-normal control a state referring to computer controlled aircraft
NR	main rotor speed
NWA	Nosewheel Angle (degrees)
OEI	One-Engine-Inoperative

OGE	Out of Ground Effect
OM-B	Operations Manual – Part B (AFM)
OTD	Other Training Device
P0	Time from pilot controller release until initial X axis crossing (X axis defined by the resting amplitude)
P1	First full cycle of oscillation after the initial X axis crossing
P2	Second full cycle of oscillation after the initial X axis crossing
PANS	Procedure for Air Navigation Services
PAPI	Precision Approach Path Indicator System
PAR	Precision Approach Radar
Pf	Impact or feel pressure
PLA	Power Lever Angle
PLF	Power for Level Flight
Pn	Sequential period of oscillation
POM	Proof-of-Match
PSD	Power Spectral Density
psi	pounds per square inch. (1 psi = 6.89476 kPa)
PTT	Part-Task Trainer
QTG	Qualification Test Guide
R/C	Rate of Climb (m/s or ft/min)
R/D	Rate of Descent (metres/s or ft/min)
RAE	Royal Aerospace Establishment
RAeS	Royal Aeronautical Society
REIL	Runway End Identifier Lights
RNAV	Radio Navigation
RVR	Runway Visual Range (m or ft)
s	second(s)
sec(s)	second, seconds
sm	statute mile, 1 statute mile = 5 280 ft = 1 609 m
SOC	Statement of Compliance
SUPPS	Supplementary Procedures referring to Regional Supplementary Procedures
TCAS	Traffic Alert and Collision Avoidance System
T(A)	Tolerance applied to Amplitude
T(p)	Tolerance applied to Period
T/O	Take-Off
Tf	Total time of the flare manoeuvre duration
Ti	Total time from initial throttle movement until a 10% response of a critical engine parameter
TLA	Throttle Lever Angle
TLOF	Touch Down and Lift-off
TDP	Take-off Decision Point
Tt	Total time from Ti to a 90% increase or decrease in the power level specified
VASI	Visual Approach Slope Indicator System
VDR	Validation Data Roadmap
VFR	Visual Flight Rules
VGS	Visual Ground Segment
Vmca	Minimum Control Speed (air)
Vmcg	Minimum Control Speed (ground)
Vmcl	Minimum Control Speed (landing)
VOR	VHF Omni-directional Range
Vr	Rotate Speed
VS	Stall Speed or Minimum Speed in the Stall
V1	Critical Decision Speed
VTOSS	Take-off Safety Speed
V_Y	Optimum Climbing Speed

Vw	Wind Velocity
WAT	Weight, Altitude, Temperature

CHAPTER 2 REQUIREMENTS FOR HELICOPTER SIMULATORS

1. Application for Flight Simulation Training Device Qualification

1.1 The operator of a FSTD which requires evaluation must apply to the Department giving 3 months notice. A sample Letter of Application is provided at Chapter 2 Appendix 1, Part A. The MQTG is to be submitted not later than 30 days prior to the qualification. A sample covering letter is included at Chapter 2 Appendix 1, Part B. Prior to the evaluation the operator is to attest that they have completed all necessary tests and that the simulator is representative of the aircraft. A sample letter is included at Chapter 2 Appendix 1, Part C.

1.2 A FSTD qualification letter will be issued following satisfactory completion of an evaluation. A sample Letter of Simulator Qualification and Report is provided at Chapter 2 Appendix 2.

2. Validation of Flight Simulation Training Device Qualification

2.1 A FSTD qualification is valid for 12 months unless otherwise specified by the Department. The CAD reserves the right to perform FSTD evaluations whenever it deems it necessary.

2.2 A FSTD qualification test for revalidation may take place at any time within the 60 days prior to 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.

2.3 The CAD may refuse, revoke, suspend or vary a FSTD qualification, if the provisions of CAD 453(H) are not satisfied.

3. Rules governing Flight Simulation Training Device Operators

3.1 Quality system

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

3.1.2 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. The Quality System and the Quality Manager shall be acceptable to the Department and the Quality System shall be described in relevant documentation.

3.2 Updating

3.2.1 A simulator operator should maintain a link with manufacturers to incorporate important modifications, especially:

(a) *helicopter modifications*. Helicopter modifications, whether or not enforced by an airworthiness directive, and which are essential for training and checking, shall be introduced into all affected FSTDs; and

(b) FSTD modifications. Modification of FSTDs including motion and visual systems:

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

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

3.3 Installation

3.3.1 The FSTD operator must ensure that a FSTD is housed in suitable premises which support safe and reliable operation and that the simulator, and its installation comply with Hong Kong regulations for Health and Safety.

3.4 Safety briefing

3.4.1 The FSTD operator must ensure that FSTD occupants and maintenance personnel are briefed on simulator safety to ensure that they are aware of all safety equipment and its siting in the simulator in case of emergency.

3.5 Fire protection

3.5.1 The FSTD operator must ensure that adequate fire/smoke detection, warning and suppression arrangements are installed to ensure the safe passage of personnel from the FSTD. Prominent escape route floor markings must be provided to guide personnel away from the simulator site to the nearest exit from the accommodation building.

3.6 System hazards

3.6.1 The FSTD operator must ensure adequate protection against electrical, mechanical, hydraulic and pneumatic hazards - including those arising from the control loading and motion systems to ensure the maximum safely of all personnel in the vicinity of the simulator.

3.7 Other safety items

3.7.1 The FSTD operator must ensure that the following safety items are installed and maintained in an effective operational condition:

(a) two-way communication system which remains operational in the event of total power failure;

(b) emergency lighting;

(c) escape exits & facilities;

(d) occupant restraints (seats, seat belts etc.);

(e) external warning of motion and access ramp or stairs activity;

(f) danger area markings;

(g) guard rails and gates;

(h) motion & control loading emergency Stop controls accessible from both pilot's seats and the instructor's seat; and

(i) a manual or automatic electrical power isolation switch.

3.8 Safety systems checks

3.8.1 The FSTD operator must ensure that simulator safety features such as emergency stops and emergency lighting are checked regularly, but in any case, at least annually. These tests must be recorded.

4. Requirements for Flight Simulation Training Device

4.1 Any flight simulator submitted for initial evaluation will be evaluated against CAD 453(H) criteria for the qualification levels applied for.

4.2 A flight simulator must be assessed in those areas which are essential to completing the flight crew member training and checking process.

4.3 The Flight Simulator must be subjected to:

4.3.1 validation tests; and

4.3.2 functions & subjective tests as found in the Qualification Test Guide (QTG).

4.4 Data which is used to ensure the fidelity of a flight simulator must be of a standard that satisfies the CAD before the flight simulator can gain a qualification level. The simulator operator must submit a QTG in a form and manner acceptable to the CAD.

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

4.6 The simulator operator shall:

4.6.1 run the complete MQTG progressively between each annual evaluation by the CAD. Results shall be dated and retained in order to satisfy both the simulator operator as well as the CAD that simulator standards are being maintained; and

4.6.2 establish a Configuration Control System to ensure the continued integrity of the hardware and software qualified.

5. Re-categorisation of Flight Simulation Training Device

5.1 Flight simulators approved or qualified in accordance with previous regulations will either be re-categorised or will continue to maintain approval under the grandfather rights provision in accordance with following guidelines and those in Chapter 8.

5.2 Re-categorised flight simulators will be qualified in accordance with CAD 453(H). Flight simulators that are not re-categorised but that have a primary reference document used for their testing may be qualified by the CAD to an equivalent CAD 453 qualification level, either AG, BG, CG or DG. These qualification levels refer to similar credits achieved by CAD 453(H) Levels A, B, C & D.

5.3 To gain and maintain an equivalent qualification level, these flight simulators must be assessed in those areas which are essential to completing the flight crew member training and checking process.

5.4 The flight simulator must be subjected to:

5.4.1 validation tests; and

5.4.2 functions and subjective tests.

5.5 Flight simulators that are not re-categorised and that do not have a primary reference document used for their testing must be qualified by special arrangement. Such simulators will be issued with special categories and must be subjected to the same functions and subjective tests referred to in sub-paragraph 5.4.2. In addition, any previously recognized validation test must be used.

6. Changes to qualified Flight Simulation Training Device

6.1 Requirement to notify major changes to a FSTD

6.1.1 The operator of a qualified FSTD must inform the CAD of proposed major changes such as:

(a) helicopter modifications which could affect FSTD qualification;

(b) FSTD hardware and/or software modifications which could affect the handling qualities, performances or system representations;

(c) relocation of the flight simulator; and

(d) any deactivation of the flight simulator.

Note: The CAD may complete a special evaluation following major changes or when a FSTD appears not to be performing at its initial qualification level.

6.2 Upgrade of a Flight Simulation Training Device

6.2.1 A FSTD may be upgraded to a higher qualification level. Special evaluation is required before the award of a higher level of qualification.

6.2.2 If an upgrade is proposed the FSTD operator must seek the advice of the CAD 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 FSTD to continue to qualify even at the previous level.

6.2.3 In the case of a FSTD upgrade, a FSTD operator shall run all validation tests for the requested qualification level. Validation test results offered in a test guide for previous initial or upgrade evaluation shall not be used to validate simulator performance in a test guide offered for a current upgrade.

6.3 Relocation of a Flight Simulation Training Device

6.3.1 In instances where a FSTD is moved to a new location, the CAD must be advised before the planned activity along with a schedule of events related thereto.

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

6.3.3 At the discretion of the CAD, the simulator shall be subject to an evaluation in accordance with its original CAD qualification criteria.

6.4 Deactivation of a Currently-Qualified Flight Simulation Training Device

6.4.1 In the event a FSTD operator plans to remove a simulator from active status for prolonged periods, the CAD must be notified, and suitable controls established for the period the FSTD is inactive.

6.4.2 The FSTD operator shall agree a procedure with the CAD to ensure that the FSTD can be restored to active status at its original qualification level.

7. Interim Flight Simulation Training Device Qualification

7.1 In case of new helicopter programs, special arrangements shall be made to enable an interim qualification level to be achieved.

7.2 Requirements, details relating to the issue, and the period of validity of an interim qualification level will be decided by the CAD.

8. Transferability of Flight Simulation Training Device Qualification

8.1 When there is a change of FSTD operator, the new operator must advise the CAD in advance in order to agree upon a plan of transfer of the FSTD.

8.2 At the discretion of the CAD, the FSTD shall be subject to an evaluation in accordance with its original CAD qualification criteria.

8.3 Provided that the FSTD performs to its original standard, its original qualification level shall be restored.

9. Minimum simulator requirements for qualifying CAD 453(H)

9.1 This document describes the general technical requirements for qualifying CAD Level A, B, C and D full flight simulators, FTD levels 1, 2, and 3, FNPT levels I, II, III and MCC. Each of these four levels carries an appropriate technical description.

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

9.3 Specific requirements for the use of the aircraft or simulator will be determined by the CAD. Specialized training courses (e.g. ETOPS, TCAS, LWMO, Windshear etc.) require an adequate standard of simulation which will be evaluated by the CAD.

Note: Certain simulator and visual system requirements included shall be supported with a Statement of Compliance (SOC) and, in some designated cases, an Objective Test. Compliance statements shall describe how the requirement was met, such as gear modeling approach, coefficient of friction sources, etc.

CHAPTER 2 APPENDIX 1

Part A

To be submitted not less than 3 months prior to requested qualification date.

LETTER OF APPLICATION FOR CAD EVALUATION OF FLIGHT SIMULATOR

(Date) ....

CHIEF, FLIGHT STANDARDS
Address

Dear Sir,

.... (Name of Applicant) .... requests the evaluation of its .... (type) .... Flight Simulator for Level .... (A, B,C or D) qualification. The .... (Simulator Manufacturer Name) ....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) ....

Evaluation is requested for the following configurations and engine fits as applicable:
e.g. H-175
1……………………
2……………………
3……………………

Dates requested are .... and the FSTD will be located at ……………………………………………………………………………………………

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

Comments:
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

Yours faithfully,

Print Name
Position/Appointment held

Part B

To be completed with attached QTG results

(Date) ....

We have completed tests of the FSTD detailed in Part A and declare that it meets all applicable requirements of CAD 453(H) except as noted below. Appropriate hardware and software configuration control procedures have been established and these are appended for your inspection and approval. Attached to this application is a list of known outstanding issues.

It is expected that they will be completed and submitted 3-weeks prior to the evaluation date.

Signed

....

Print name ....
Position/appointment held ....

Part C

To be completed not less than 7-days prior to initial evaluation

(Date) ....

The Simulator has been assessed by the following evaluation team:
.... (name) .... Qualification ....
.... (name) .... Qualification ....
.... (name) .... Qualification ....
.... (name) .... Pilot's Licence No...................
.... (name) .... Flight Engineer's Licence No. (if applicable) ....

This team attest(s) that it conforms to the helicopter flight deck configuration of .... (Name of simulator 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 simulator and finds that it represents the designated helicopter.
Attached is a list of known outstanding deficiencies.
(Additional comments as required)
……
……
……
……

Signed

……………………
Print name ……………………
Position/appointment held ……………………

CHAPTER 2 APPENDIX 2

香港特別行政區政府
民航處
Civil Aviation Department
The Government of the Hong Kong Special Administrative Region

Air Navigation (Hong Kong) Order 1995

FLIGHT SIMULATOR APPROVAL
飛行模擬機認可合格証

1. (a) SIMULATOR OPERATOR 模擬機運營人 [the operator]
   (b) LOCATION 地點 Hong Kong
   (c) SIMULATOR TYPE 模擬機類型 Full Flight Simulator
   SIM CODE 模擬機編號 XXX- YY
   (d) SIMULATOR MANUFACTURER 模擬機製造廠 Airbus
   (e) VISUAL MANUFACTURER & TYPE 視景製造廠及類型 XXX Co. Ltd.
2. (a) AIRCRAFT TYPE /~~VARIANTS EVALUATED~~ 飛機型號/變型審查 Airbus H175
   (b)

ENGINE TYPE 發動機型號	ENGINE INSTRUMENTATION 發動機儀表器	FLIGHT INSTRUMENTATION 飛行航班儀表器	OTHER 其他
Pratt & Whitney PT 6	VMS	EFIS	EGPWS & TCAS 7

3. (a) DATE OF EVALUATION 審查日期 21 May 2019
   (b) DATE OF PREVIOUS 前次日期 21 May 2018
4. CAD LEVEL OF QUALIFICATION GRANTED 民航處之批核資格的等級

A	B	C	D

5. COMMENTS/RESTRICTIONS 意見或限制令

   NIL

I, Captain YYY, being a person duly delegated, hereby approve pursuant to paragraph 3 of Part C of Schedule 9 and paragraph 1(2) of Part B Schedule 11 to the Air Navigation (Hong Kong) Order 1995 the flight simulator specified above for the purpose of the tests specified in column 1 of the Authority to this Approval, being tests in relation to the EC-175 type of aircraft.

This Approval shall remain in force, unless previously revoked, from the date shown below until DD day of MMM YYYY.
Approval AL/033/2010 dated 3rd day of June 2018 is hereby revoked.

(Captain YYY)
for Director-General of Civil Aviation

Approval No.: AL/XXX/XXXX
Dated the DD day of MMM YYYY

[the operator]
Authority to **Co**nduct Tests in
EC175 SIMULATOR – CODE XXX YY
in accordance with Approval Document
Approval No.: AL/XXX/XXXX
dated DD day of MMM YYYY and Form DCA 528

COLUMN 1 TEST TO BE CONDUCTED	COLUMN 2 PERSONS TO CONDUCT TESTS
(i) <u>Pilot Test for Aircraft Rating Renewal</u> a test pursuant to paragraph 3 of Part C of the Schedule 9 to the Air Navigation (Hong Kong) Order 1995, Form DCA 528 items 4.2010, 4.20.11 and 4.20.12.	<u>Pilot Test for Aircraft Rating Renewal</u> persons for the time being nominated by [the operator] who hold authority to conduct E175 Aircraft Rating Renewal tests and sign Certificates of Test.
(ii) <u>Instrument Rating Renewal Test</u> a test pursuant to paragraph 3(c) of Part C of Schedule 9 to the Air Navigation (Hong Kong) Order 1995.	<u>Instrument Rating Renewal Test</u> persons for the time being nominated by [the operator] who hold authority to conduct Instrument Rating Renewal Tests and sign Instrument Rating Renewal Certificates of Test.
(iii) <u>Pilot Competence Test</u> a test pursuant to paragraph 1(2)(a)(ii) and 1(2)(b)(ii) of Part B of the Schedule 11 to the Air Navigation (Hong Kong) Order 1995.	<u>Pilot Competence Test</u> persons for the time being nominated by [the operator] who are approved for the purposes of supervising such tests.
(iv) <u>Instrument Approach-to-Land Test</u> a test pursuant to paragraph 1(2)(c)(i) of Part B of the Schedule 11 to the Air Navigation (Hong Kong) Order 1995.	<u>Instrument Approach-to-Land Test</u> persons for the time being nominated by [the operator] who are approved for the purposes of supervising such tests.

Note :

(1) Persons holding authority to conduct tests pursuant to Schedule 9 shall, when appointed by [the operator] to conduct tests pursuant to Schedule 11 on a flight simulator approved for the purpose, be deemed as persons approved for the purposes of supervising such tests.

(2) Tests may only be undertaken by persons who are employed by [the operator] or by persons authorised to do so in a particular case.

(3) a) the motion system must be serviceable and utilised for the tests stated in this Schedule;

b) the visual system must be serviceable and utilised for the tests stated in this Schedule;

CHAPTER 3 FLIGHT SIMULATOR EVALUATIONS

1. General

1.1 To gain a qualification level, a simulator is evaluated in accordance with a structured routine conducted by a technical team which is appointed by the CAD and consists of at least:

1.1.1 a Technical Flight Simulator Inspector of the CAD qualified in all aspects of flight simulation hardware, software and computer modelling or, exceptionally, a person designated by the CAD with equivalent qualifications;

1.1.2 a pilot approved by CAD to furnish reports on C of A air tests on the aircraft type involved; and

1.1.3 a Flight Operations Inspector of CAD, normally type-rated.

1.2 During initial and recurrent simulator evaluations it will be necessary for the CAD to conduct the Objective and Subjective Tests described in Chapter 5 and Chapter 6. There will be occasions when all tests cannot be completed - for example during recurrent evaluations on a convertible simulator - but arrangements should be made for all tests to be completed within a reasonable time.

1.3 Following an evaluation, it is possible that a number of defects may be identified. Generally these defects should be rectified and the CAD 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 a period greater than 30 days, subsequent downgrading may occur.

2. Initial evaluations

2.1 Objective Testing

2.1.1 Objective Testing is centered 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 CAD 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 CAD 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 CAD will not necessarily warn the 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 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 Chapter 6.

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

2.3.1 To ensure adequate coverage of objective and subjective tests and to allow rectification and retest, three consecutive days should be dedicated to an initial evaluation of a flight simulator.

3. Recurrent Testing

3.1 Objective Testing

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

3.1.2 Essentially the time taken to run the objective tests depends upon the need for special equipment and the test system, and the simulator cannot be used for subjective tests or other functions whilst testing is in progress. For a modern simulator incorporating an automatic test system, four (4) hours would normally be required. Simulators which rely upon manual testing may require a longer period of time.

3.2 Subjective Testing

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

3.3 Conclusion

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

3.4 Functions and subjective tests – suggested test routine

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

3.4.2 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.

3.4.3 The 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 not present an unnecessary distraction from observing the activities of the flight crew whilst providing adequate facilities for the tasks.

3.4.4 Chapter 2 prescribes the requirements for flight simulator qualification. It is important that both the CAD and the simulator 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.

CHAPTER 4 TESTING FOR SIMULATOR QUALIFICATION

1. General

1.1 This Chapter establishes the standards which define the performance and documentation requirements for the evaluation of helicopter flight simulators used for training, testing and checking of cockpit crew members.

2. Simulator qualification

2.1 Simulator assessment

2.1.1 The 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 and lateral-directional responses; performance in take-off, climb, cruise, descent, approach, landing; specific operations; control checks; cockpit, flight engineer, and instructor station functions 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.

2.2 Evaluation

2.2.1 The intent is to evaluate the simulator as objectively as possible. Pilot acceptance, however, is also an important consideration. Therefore, the simulator will be subjected to validation, functions and subjective tests listed in Chapters 5 and 6 of this document. Validation tests are used to compare objectively 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 simulator.

2.3 Tolerances

2.3.1 Tolerances listed for parameters in the validation tests in Chapter 5 of this document are the maximum acceptable for simulator qualification and should not be confused with simulator design tolerances.

2.4 Initial qualification

2.4.1 For initial qualification testing of 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 CAD.

2.5 New helicopter programs

2.5.1 In the case of new helicopter programs, 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 CAD, simulator operator, simulator manufacturer, and helicopter manufacture.

3. Types of evaluations

3.1 Initial evaluation

3.1.1 Initial evaluation is the first evaluation of a simulator to qualify it for use by an operator. It consists of a technical review of the Qualification Test Guide (QTG) and a subsequent on-site validation of the simulator to ensure it meets all the requirements of the standard.

3.2 Recurrent evaluations

3.2.1 Recurrent evaluations are those evaluations accomplished periodically to ensure that the simulator retains its status as initially qualified.

3.3 Special evaluations

3.3.1 Special evaluations are those that may be accomplished resulting from any of the following circumstances:

(a) a major hardware and/or software change which may affect the handling qualities, performance or systems representations of the simulator; and

(b) a situation discovered that indicates the simulator is not performing to its initial qualification standard.

4. Qualification Test Guide (QTG)

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

4.2 The FSTD operator should submit a QTG which includes the following:

4.2.1 a title page with FSTD operator and approval department signature blocks;

4.2.2 a simulator information page (for each configuration in the case of convertible FSTDs) providing:

(a) FSTD operator's FSTD identification number.

(b) helicopter model and series being simulated.

(c) references to aerodynamic data or sources for aerodynamic model.

(d) references to engine data or sources for engine model.

(e) references to flight control data or sources for flight controls model.

(f) avionic equipment system identification where the revision level affects the training and checking capability of the FSTD.

(g) simulator model and manufacturer.

(h) date of simulator manufacture.

(i) simulator computer identification.

(j) visual system type and manufacturer.

(k) motion system type and manufacturer.

(l) sound system type and manufacturer.

4.2.3 table of contents;

4.2.4 list of effective pages and log of test revisions;

4.2.5 listing of all reference and source data;

4.2.6 glossary of terms and symbols used;

4.2.7 Statements of Compliance (SOC) with certain requirements. SOC's should refer to sources of information and show compliance rationale to explain how the referenced material is used, applicable mathematical equations and parameter values, and conclusions reached. Refer to Chapter 4 Appendices 1 and 2 'FSTD Standards' and Chapter 5 Appendices 1 and 2 'Table of FSTD Validation Tests' 'Comments' column, for SOC requirements;

4.2.8 recording procedures and required equipment for the validation tests;

4.2.9 the following items for each validation test designated in Chapter 5 Appendix 1:

(a) *Test Title*. This should be short and definitive, based on the test title referred to in Chapter 5;

(b) *Test Objective*. This should be a brief summary of what the test is intended to demonstrate;

(c) *Demonstration Procedure*. This is a brief description of how the objective is to be met;

(d) *References*. These are the helicopter data source documents including both the document number and the page or condition number;

(e) *Initial Conditions*. A full and comprehensive list of the test initial conditions is required;

(f) Manual Test Procedures. Procedures should be sufficient to enable the test to be flown by a qualified pilot, using reference to flight deck instrumentation and without reference to other parts of the QTG or flight test data or other documents

(g) *Automatic Test Procedures*. Level C & D QTGs should include provisions for automatically conducting the test;

(h) *Evaluation Criteria*. Specify the main parameter(s) under scrutiny during the test;

(i) *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;

(j) *Test Result*. Dated FSTD validation test results obtained by the FSTD operator. Tests run on a computer which is independent of the simulator are not acceptable.

(k) *Source Data*. Copy of the helicopter source data, (in the case of FFS/FTD) or other validation data (in the case of FNPT) clearly marked with the document, page number, issuing authority, and the test number and title as specified subpara 4.2.1 above. Computer generated displays of flight test data over-plotted with FSTD data are insufficient on their own for this requirement; and

(l) *Comparison of Results*. An acceptable means of easily comparing simulator test results with the validation flight test data.

(m) The preferred method is *over-plotting*. The FSTD operator's FSTD test results should be recorded on a multi-channel recorder, line printer, electronic capture and display or other appropriate recording media acceptable to the CAD conducting the test. FSTD 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 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 Chapter 5. The test guide will provide the documented proof of compliance with the FSTD validation tests in the tables in Chapter 5. For tests involving time histories, flight test data sheets, FSTD test results should be clearly marked with appropriate reference points to ensure an accurate comparison between the FSTD and helicopter with respect to time. FSTD 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 FSTD operator's FSTD data to helicopter data is essential to verify FSTD performance in each test. The evaluation serves to validate the FSTD operator.s FSTD test results.

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

4.2.11 Use of an electronic qualification test guide (eQTG) can reduce costs, save time and improve timely communication, and is becoming a common practice. ARINC Report 436 defines an eQTG standard.

4.2.12 A Statement of Compliance (SOC) covering the 'Functions and Subjective Tests' designated in Chapter 6.

5. Configuration control

5.1 The configuration control system shall be established and maintained and subject to audit as part of the quality system to confirm its effectiveness in ensuring the continued integrity of the hardware and software as originally qualified.

6. Procedures for initial simulator qualification

6.1 A modern simulator is a complex device and the CAD evaluation can at best be only a sample check. The CAD therefore relies on the operator to ensure the device is thoroughly tested by its staff with the appropriate competencies.

6.2 The request for evaluation should reference the QTG and also include a statement that the operator has thoroughly tested the simulator and that it meets the criteria described in this document except as noted in the application form. The 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.

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

6.4 The operator may elect to accomplish the QTG validation tests while the The The operator may elect to accomplish the QTG validation tests while the simulator is at the 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 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 CAD. After review of these tests, the CAD will schedule an initial evaluation. The QTG should be clearly annotated to indicate when and where each test was accomplished.

7. Simulator recurrent qualification basis

7.1 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.

7.2 The simulator operator should run the complete Master QTG (MQTG) - which includes validation, functions & subjective tests (Chapter 6) - between each annual evaluation by the CAD. As a minimum, the QTG tests should be run progressively in at least four approximately equal three-monthly blocks on an annual cycle. Each block of QTG tests should be chosen to provide coverage of the different types of validation, functions & subjective tests. Results shall be dated and retained in order to satisfy both the FSTD operator as well as the CAD that the FSTD standards are being maintained. It is not acceptable that the complete QTG is run just prior to the annual evaluation.

CHAPTER 4 APPENDIX 1

Flight Simulation Training Device Standards

1. This Appendix describes the minimum full flight simulator (FFS), flight training device (FTD) and flight navigation procedures trainer (FNPT) requirements for qualifying devices to the required qualification levels. Certain requirements included in this guidance material should be supported with a statement of compliance (SOC) and, in some designated cases, an objective test. The SOC shall describe how the requirement was met. The test results should show that the requirement has been attained. In the following tabular listing of FSTD standards, statements of compliance are indicated in the compliance column.

2. For FNPT use in multi-crew cooperation (MCC) training the general technical requirements are expressed in the MCC column with additional systems, instrumentation and indicators as required for MCC training and operation.

3. For MCC, the minimum technical requirements are as for FNPT level II or III, with the following additions or amendments:

(i)	Multi-engine and multi-pilot helicopter
(ii)	Performance reserves, in case of an engine failure, to be in accordance with Category A criteria
(iii)	Anti-icing or de-icing systems
(iv)	Fire detection / suppression system
(v)	Dual controls
(vi)	Autopilot with upper modes
(vii)	2 VHF transceivers
(viii)	2 VHF NAV receivers (VOR, ILS, DME)
(ix)	1 ADF receiver
(x)	1 Marker receiver
(xi)	1 transponder
(xii)	Weather radar

4. The following indicators shall be located in the same positions on the instrument panels of both pilots:

(i)	Airspeed
(ii)	Flight attitude
(iii)	Altimeter and radio altimeter
(iv)	HSI
(v)	Vertical Speed
(vi)	ADF
(vii)	VOR, ILS, DME
(viii)	Marker indication
(ix)	Stop watch

CHAPTER 4 APPENDIX 2

FLIGHT SIMULATION TRAINING DEVICE STANDARDS

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL			FNPT LEVEL				COMPLIANCE
		A	B	C	D	1	2	3	I	II	III	MCC	
	1.1 General												
a.1	A cockpit that is a full-scale replica of the helicopter simulated. Additional required crew member duty stations and those required bulkheads aft of the pilot seats are also considered part of the cockpit and shall replicate the helicopter.	✓	✓	✓	✓		✓	✓					
	A cockpit that replicates the helicopter.					✓			✓	✓	✓	✓	
a.2	The cockpit, including the instructor's station is fully enclosed.	✓	✓	✓	✓								
	A cockpit, including the instructor's station that is sufficiently closed off to exclude distractions.					✓	✓	✓	✓	✓	✓	✓	
b.1	Full size panels with functional controls, switches, instruments and primary and secondary flight controls, which shall be operating in the correct direction and with the correct range of movement.	✓	✓	✓	✓	✓	✓	✓					For FTD level 1 as appropriate for the replicated system. The use of electronically displayed images with physical overlay or masking for FSTD instruments and/or instrument panels incorporating instrument controls and switches that replicate those of the helicopter and operate with the same technique, effort, travel and in the same direction may be acceptable.
	Functional controls, switches, instruments and primary and secondary flight controls sufficient for the training events to be accomplished, shall be located in a spatially correct area of the cockpit.								✓	✓	✓	✓	FSTD instruments and/or instrument panels using electronically displayed images with physical overlay or masking and operable controls representative of those in the type of helicopter are acceptable. The instruments displayed should be free of quantisation (stepping).
c.1	Lighting for panels and instruments shall be as per the helicopter.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL			FNPT LEVEL				COMPLIANCE
		A	B	C	D	1	2	3	I	II	III	MCC	
c.2	Cockpit ambient lighting environment shall be dynamically consistent with the visual display and sufficient for the training event.			✓	✓								
	The ambient lighting should provide an even level of illumination which is not distracting to the pilot.	✓	✓				✓	✓		✓	✓	✓	
d.1	Relevant cockpit circuit breakers shall be located as per the helicopter and shall function accurately when involved in operating procedures or malfunctions requiring or involving flight crew response.	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
e.1	Effect of aerodynamic changes for various combinations of airspeed and power normally encountered in flight, including the effect of change in helicopter attitude, aerodynamic and propulsive forces and moments, altitude, temperature, mass, centre of gravity location and configuration.	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	Effects of C_g, mass and configuration changes are not required for FNPT level I.
	Aerodynamic and environment modelling shall be sufficient to permit accurate systems operation and indication.					✓							
e.2	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 stabilisation systems, and representations of nonlinearities due to sideslip, vortex ring and retreating blade stall.			✓	✓		✓	✓		✓	✓	✓	
f.1	Validation flight test data shall be used as the basis for flight and performance and systems characteristics.		✓	✓	✓			✓					
	Representative/generic aerodynamic data tailored to the helicopter with fidelity sufficient to meet the objective tests and sufficient to permit accurate system operation and indication.	✓				✓	✓		✓	✓	✓	✓	Aerodynamic data need not be necessarily based on flight test data.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL			FNPT LEVEL				COMPLIANCE
		A	B	C	D	1	2	3	I	II	III	MCC	
g.1	All relevant cockpit instrument indications automatically respond to control movement by a crew member, helicopter performance, or external simulated environmental effects upon the helicopter.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
h.1	All relevant communications, navigation, caution and warning equipment shall correspond to that installed in the helicopter. All simulated navigation aids within range shall be usable without restriction. Navigational data shall be capable of being updated.	✓	✓	✓	✓	✓	✓	✓					For FTD 1 applies where the appropriate systems are replicated.
h.2	Navigation equipment corresponding to that of a helicopter, with operation within the tolerances typically applied to the airborne equipment. This shall include communication equipment (interphone and air/ground communications systems).								✓	✓	✓	✓	
h.3	Navigational data with the corresponding approach facilities. Navigation aids should be usable within range without restriction.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	For FFSs and FTDs the navigation database should be updated within 28 days. For FNPTs complete navigational data for at least five different European airports with corresponding precision and non-precision approach procedures including current updating within a period of three months.
i.1	In addition to the flight crew member stations, at least two suitable seats for the instructor and an additional observer shall be provided permitting adequate vision to the crew members' panel and forward windows. Observer and instructor seats need not represent those found in the helicopter but shall be adequately secured to the floor of the FFS, fitted with positive restraint devices and be of sufficient integrity to safely restrain the occupant during any known or predicted motion system excursion.	✓	✓	✓	✓								The competent authority shall consider options to this standard based on unique cockpit configurations. Any additional seats installed shall be equipped with similar safety provisions.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		**FFS LEVEL**				**FTD LEVEL**			**FNPT LEVEL**				**COMPLIANCE**
		A	**B**	**C**	**D**	**1**	**2**	**3**	**I**	**II**	**III**	**MCC**	
i.2	Crew member seats shall afford the capability for the occupants to be able to achieve the design eye reference position. In addition to the flight crew member stations, at least two suitable seats for the instructor and an additional observer shall be provided permitting adequate vision to the crew members' panel and forward windows.					✓	✓	✓	✓	✓	✓	✓	The instructor's and observer's seats need not represent those found in the helicopter.
j.1	FFS systems shall simulate the applicable helicopter system operation, both on the ground and in flight. Systems shall be operative to the extent that normal, abnormal, and emergency operating procedures appropriate to the simulator application can be accomplished. Once activated, proper system operation shall result from system management by the flight crew and not require input from instructor controls.	✓	✓	✓	✓								
j.2	FTD systems represented shall be fully operative to the extent that normal, abnormal and emergency operating procedures can be accomplished. Once activated, proper system operation shall result from system management by the flight crew and not require input from instructor controls.					✓	✓	✓					
j.3	The systems should be operative to the extent that it should be possible to perform normal, abnormal, and emergency operations appropriate to a helicopter as required for training. Once activated, proper systems operations should result from the system management by the crew member and not require any further input from the instructor's controls.								✓	✓	✓	✓	
k.1	The instructor shall be able to control system variables and insert abnormal or emergency conditions into the helicopter systems. Independent freeze and reset facilities shall be provided.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	FNPT I: applicable only to enable the instructor to carry out selective failure of basic flight instruments and navigation equipment. For FNPT level I: ability to set the FNPT to minimum IMC speed or above.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL			FNPT LEVEL				COMPLIANCE
		A	B	C	D	1	2	3	I	II	III	MCC	
1.1	Control forces and control travel which correspond to that of the replicated helicopter. Control forces shall 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.
	Control forces and control travel shall be representative of the replicated helicopter under the same flight conditions as in the helicopter.					✓	✓	✓					For FTD level 1 as appropriate for the system training required.
	Control forces and control travel shall broadly correspond to that of a helicopter.								✓				Only static control force characteristics need to be tested.
	Control forces and control travels shall respond in the same manner under the same flight conditions as in a helicopter.									✓	✓	✓	Only static control force characteristics need to be tested.
1.2	Cockpit control dynamics, which replicate the helicopter simulated. Free response of the controls shall match that of the helicopter within the given tolerance. Initial and upgrade evaluation shall include control free response (cyclic, collective, and pedal) measurements recorded at the controls. The measured responses shall correspond to those of the helicopter in ground operations, hover, climb, cruise, and auto-rotation.		✓	✓	✓		✓	✓					For helicopters with irreversible control systems, measurements may be obtained on the ground. Engineering validation or helicopter manufacturer rationale shall be submitted as justification for ground test or to omit a configuration. For FFS requiring static and dynamic tests at the controls, special test fixtures shall not be required during the initial evaluations if the FSTD 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. FTD level 2 aerodynamic data can be representative/generic and need not necessarily be based on flight test data.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL			FNPT LEVEL				COMPLIANCE
		A	B	C	D	1	2	3	I	II	III	MCC	
m.1	Ground handling and aerodynamic programming to include the following: Ground effect - hover and transition IGE. (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. 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.
	Ground handling and aerodynamic ground effects models should be provided to enable lift-off, hover, and touch down effects to be simulated and harmonised with the sound and visual system.						✓	✓					
	Generic ground handling and aerodynamic ground effects models should be provided to enable lift-off, hover, and touch down effects to be simulated and harmonised with the sound and visual system.									✓	✓	✓	
n.1	Instructor controls for: (i) wind speed and direction	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
	(ii) turbulence	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
	(iii) other atmospheric models to support the required training				✓			✓			✓	✓	Examples: generic atmospheric models of local wind patterns around mountains and structures.
	(iv) adjustment of cloud base and visibility	✓	✓	✓	✓		✓	✓		✓	✓	✓	
	(v) temperature and barometric pressure.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL			FNPT LEVEL				COMPLIANCE
		A	**B**	**C**	**D**	**1**	**2**	**3**	**I**	**II**	**III**	**MCC**	
o.1	Representative stopping and directional control forces for at least the following landing surface conditions based on helicopter related data, for a running landing: (i) dry (ii) wet (soft surface and hard surface) (iii) icy (iv) patchy wet (v) patchy icy			✓	✓								
p.1	Representative brake and tire failure dynamics.			✓	✓								
q.1	(1) Transport delay. Transport delay is the time between control input and the individual hardware (systems) responses. As an alternative, a latency test may be used to demonstrate that the FSTD system does not exceed the permissible delay.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	For FTD level 1, only instrument response is required within a maximum permissible delay of 200 ms. For level 'A' & 'B' FFS and level 2 FTD the maximum permissible delay is 150 ms. For level 'C' & 'D' FFS and level 3 FTD the maximum permissible delay is 100 ms.
	(2) Latency. Relative response of the visual system, cockpit instruments and initial motion system response shall be coupled closely to provide integrated sensory cues. These systems shall 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 shall occur within the system dynamic response limit but not before the resultant motion onset.	✓	✓	✓	✓	✓	✓	✓					For FTD level 1 and FNPT level I, only instrument response is required within a maximum permissible delay of 200 ms. For level 'A' & 'B' FFS, level 2 FTD and FNPT level II and III the maximum permissible delay is 150 ms. For level 'C' & 'D' FFS and level 3 FTD the maximum permissible delay is 100 ms.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL			FNPT LEVEL				COMPLIANCE
		A	**B**	**C**	**D**	**1**	**2**	**3**	**I**	**II**	**III**	**MCC**	
r.1	A means for quickly and effectively testing FSTD 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.	✓	✓				✓				✓	✓	Recommended for FTD Level 1, FNPT level I and II. Automatic flagging of "out-of-tolerance" tests results is encouraged.
	Self-testing for FSTD hardware and programming to determine compliance with the FSTD performance tests. Evidence of testing shall include FSTD number, date, time, conditions, tolerances, and the appropriate dependent variables portrayed in comparison with the helicopter standard.			✓	✓			✓					
s.1	A system allowing for timely continuous updating of FSTD hardware and programming consistent with helicopter modifications.	✓	✓	✓	✓	✓	✓	✓					
t.1	The FSTD operator shall submit a QTG in a form and manner acceptable to the competent authority. A recording system shall be provided that will enable the FSTD performance to be compared with QTG criteria.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
u.1	FSTD computer capacity, accuracy, resolution and dynamic response sufficient for the qualification level sought.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
v.1	Daily preflight documentation either in the daily log or in a location easily accessible for review.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL			FNPT LEVEL				COMPLIANCE
		A	B	C	D	1	2	3	I	II	III	MCC	
	1.2 Motion System												
a.1	Motion cues as perceived by the pilot shall be representative of the helicopter, e.g. touch down 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.1	A motion system:												
	Having a minimum of 3 degrees of freedom (pitch, roll, heave) to accomplish the required task.	✓											
	6 degrees of freedom synergistic platform motion system.		✓	✓	✓								For level B, a reduced motion performance envelope is acceptable.
c.1	A means of recording the motion response time as required	✓	✓	✓	✓								
d.1	Special effects programming to include the following: (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: (i) touch down (ii) translational lift; (7) antitorque device ineffectiveness; (8) buffet due to turbulence.	✓	✓	✓	✓								For level A it may be of a generic nature sufficient to accomplish the required tasks.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL			FNPT LEVEL				COMPLIANCE
		A	**B**	**C**	**D**	**1**	**2**	**3**	**I**	**II**	**III**	**MCC**	
e.1	Characteristic vibrations/buffets that result from operation of the helicopter and which can be sensed in the cockpit. Simulated cockpit vibrations to include seat(s), flight controls and instrument panel(s), although these need not be tested independently.				✓								Statement of compliance required. Tests required with recorded results which allow the comparison of relative amplitudes versus frequency in the longitudinal, lateral and vertical axes with helicopter data. Steady state tests are acceptable.
	1.3 Visual System												
a.1	Visual system capable of meeting all the standards of this paragraph and the respective paragraphs of validation tests as well as functions and subjective tests as applicable to the level of qualification requested by the FSTD operator.	✓	✓	✓	✓		✓	✓		✓	✓	✓	The choice of the display system and of the field of view requirements should fully consider the intended use of the FSTD. The balance between training and testing/checking may influence the choice and geometry of the display system. In addition the diverse operational requirements should be addressed.
b.1	Visual system capable of providing at least a 45 degree horizontal and 30 degree vertical field of view simultaneously for each pilot. Visual system capable of providing at least a 75 degrees horizontal and 40 degrees vertical field of view simultaneously for each pilot.	✓	✓										
	"Continuous", cross-cockpit, minimum visual field of view providing each pilot with 150 degrees horizontal and 40 degrees vertical			✓			✓			✓		✓	A minimum of 75 degrees horizontal field of view on either side of the zero degree azimuth line relative to the helicopter fuselage is required.
b.2	"Continuous," cross-cockpit, minimum visual field of view providing each pilot with 150 degrees horizontal and 60 degrees vertical.							✓			✓		A minimum of 75 degrees horizontal field of view on either side of the zero degree 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 150 degrees x 60 degrees, then such extended fields of view should be provided.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL			FNPT LEVEL				COMPLIANCE
		A	B	C	D	1	2	3	I	II	III	MCC	
b.3	"Continuous" cross cockpit, minimum visual field of view providing each pilot with 180 degrees horizontal and 60 degrees vertical.				✓								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.1	A means of recording the visual response time for the visual system shall be provided.	✓	✓	✓	✓		✓	✓		✓	✓	✓	
d.1	Visual cues to assess rate of change of height, translational displacements and rates, during take-off and landing.	✓	✓										For level 'A', visual cueing sufficient to support changes in approach path by using the final approach and take-off (FATO) perspective.
	Visual cues to assess rate of change of height, height AGL, translational displacements and rates, during take-off, low altitude/low airspeed manoeuvring, hover, and landing.			✓	✓		✓	✓		✓	✓	✓	
e.1	Test procedures to quickly confirm visual system colour, RVR, focus, intensity, level horizon, and attitude as compared with the specified parameters.	✓	✓	✓	✓		✓	✓		✓	✓	✓	Statement of compliance required. Test required.
f.1	A minimum of 10 levels of occulting. This capability should be demonstrated by a visual model through each channel.			✓	✓		✓	✓		✓	✓	✓	Statement of compliance required. Test required.
g.1	Surface (Vernier) resolution shall be demonstrated by a test pattern of objects shown to occupy a visual angle of not greater than 3 arc minutes in the visual display used on a scene from the pilot's eye point.			✓	✓		✓	✓		✓	✓	✓	Statement of compliance required. Test required.
h.1	Lightpoint size shall not be greater than 6 arc minutes			✓	✓								This is equivalent to a lightpoint resolution of 3 arc minutes.
	Lightpoint size shall not be greater than 8 arc minutes		✓				✓	✓		✓	✓	✓	This is equivalent to a lightpoint resolution of 4 arc minutes.

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		**FFS LEVEL**				**FTD LEVEL**			**FNPT LEVEL**				**COMPLIANCE**
		A	**B**	**C**	**D**	**1**	**2**	**3**	**I**	**II**	**III**	**MCC**	
i.1	Daylight, dusk, and night visual scenes with sufficient scene content to recognise aerodromes, operating sites, terrain, and major landmarks around the FATO area and to successfully accomplish low airspeed/low altitude manoeuvres to include lift-off, hover, translational lift, landing and touch down.			✓	✓		✓	✓		✓	✓	✓	
j.1	A visual database sufficient to support the requirements, including (i) Specific areas within the database needing higher resolution to support landings, take-offs and ground cushion exercises and training away from an aerodrome/operating site. Including elevated FATO, helidecks and confined areas. (ii) For cross-country flights sufficient scene details to allow for ground to map navigation over a sector length equal to 30 minutes at an average cruise speed. (iii) For offshore airborne radar approaches (ARA), harmonised visual/radar representations of installations. (iv) For training in the use of night vision goggles (NVG) a visual display with the ability to represent various scenes with the required levels of ambientlight/colour.		✓	✓	✓		✓	✓		✓	✓	✓	Generic database is acceptable only for FTDs and FNPTs. (ii) Where applicable. (iii) Where applicable. (iv) Where applicable.
k.1	Daylight, twilight (dusk/dawn) and night visual capability for system brightness and contrast ratio criteria as applicable for level of qualification sought.			✓	✓		✓	✓		✓	✓	✓	The ambient lighting should provide an even level of illumination, which is not distracting to the pilot.
	Night and Dusk scene.	✓	✓										
k.2	The visual system should be capable of producing: Full colourpresentations. Full colour texture shall be used to enhance visual cue perception for illuminated landing surfaces.			✓	✓		✓	✓		✓	✓	✓	

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		FFS LEVEL				FTD LEVEL			FNPT LEVEL				COMPLIANCE
		A	B	C	D	1	2	3	I	II	III	MCC	
k.3	The visual system should be capable of producing, as a minimum: (i) A scene content comparable in detail with that produced by 6 000 polygons for daylight and 1 000 visible lightpoints for night and dusk scenes for the entire visual system.						✓	✓		✓	✓	✓	Statement of compliance required. Test required. Freedom of apparent quantisation and other distracting visual effects are also applicable for levels A and B.
	(ii) A scene content comparable in detail with that produced by 4 000 polygons for daylight and 5 000 visible lightpoints for night and dusk scenes for the entire visual system.			✓									
	(iii) A scene content comparable in detail with that produced by 6 000 polygons for daylight and 7 000 visible lightpoints for night and dusk scenes for the entire visual system.				✓								
l.1	Surface contrast ratio: Demonstration model Not less than 5:1.			✓	✓		✓	✓		✓	✓	✓	
l.2	Lightpoint contrast ratio. Not less than 25:1.			✓	✓		✓	✓					
m.1	Highlight Brightness. The minimum light measured at the pilot's eye position should be: 14 cd/m² (4 ft-Lamberts)			✓									
	17 cd/m² (5ft-Lamberts)						✓	✓		✓	✓	✓	
	20 cd/m² (6 ft-Lamberts)				✓								
	1.4 Sound Systems												
a.1	Significant cockpit sounds, and those, which result from pilot actions corresponding to those of the helicopter shall be provided.	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	For FTD level 1 as appropriate for the system training required. Statement of compliance required for FFS.
a.2	Sounds due to engines, transmission and rotors should be available.								✓				

FLIGHT SIMULATION TRAINING DEVICE STANDARDS		**FFS LEVEL**				**FTD LEVEL**			**FNPT LEVEL**				**COMPLIANCE**
		A	**B**	**C**	**D**	**1**	**2**	**3**	**I**	**II**	**III**	**MCC**	
b.1	Sound of precipitation, windshield wipers, the sound resulting from a blade strike and a crash condition when operating the helicopter in excess of limitations.			✓	✓		✓	✓					Crash sounds may be generic. Statement of compliance or demonstration of representative sounds required.
c.1	Realistic amplitude and frequency of cockpit acoustic environment.				✓								Objective steady-state tests required.
d.1	The volume control shall have an indication of sound level setting which meets all qualification requirements.	✓	✓	✓	✓								

CHAPTER 5 SIMULATOR VALIDATION TESTS

1. General

1.1 Simulator performance and system operation should be objectively evaluated by comparing the results of tests conducted in the simulator with helicopter data unless specifically noted otherwise. To facilitate the validation of the simulator, a multi-channel recorder, line printer, or other appropriate recording device acceptable to the Department should be used to record each validation test result. These recordings should then be compared with the helicopter source data.

1.2 Certain visual, sound and motion tests in this paragraph 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.

1.3 The QTG provided by the operator should describe clearly and distinctly how the 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 simulators and is encouraged for all simulators. It is not the intent, nor is it acceptable, to test each simulator subsystem independently. Overall integrated testing of the simulator should be accomplished to assure that the total simulator system meets the prescribed standards. A manual test procedure with explicit and detailed steps for completion of each test should also be provided.

1.4 The tests and tolerances contained in this chapter should be included in the operator's QTG. For helicopters certified prior to January 1992, an 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 Department for approval. Submittals for approval of data other than flight test should include an explanation of validity with respect to available flight test information.

1.5 The Table of Validation Tests in Appendix 1 of this chapter generally indicates the test results required. Unless noted otherwise, 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 must include validation of augmentation devices.

1.6 For the testing of computer-controlled helicopter (CCH) FSTDs, flight test data are required for both the normal (N) and non-normal (NN) control states, as applicable to the helicopter simulated and, as indicated in the validation requirements of this paragraph. Tests in the non-normal state should always include the least augmented state. Tests for other levels of control state degradation may be required as detailed by the CAD at the time of definition of a set of specific helicopter tests for FSTD data. Where applicable, flight test data should record:

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

1.6.2 rotor blade pitch position or equivalent.

1.7 Where extra equipment is fitted, such as a motion system or in an FTD level 1 or FNPT level I, a visual system, such equipment is expected to satisfy tests as follows:

1.7.1 visual system: where fitted to an FNPT level I or FTD level 1, validation tests are those specified for a FNPT level II or for a FTD level 2 respectively; and

1.7.2 motion system: where fitted to an FTD or FNPT, validation tests are those specified for a level A FFS.

2. Test requirements

2.1 The ground and flight tests required for qualification are listed in the Table of Validation Tests (Appendix 1). Computer-generated simulator test results should be provided for each test. The results should be produced on a multi-channel recorder, line printer, or other appropriate recording device acceptable to the Department. Time histories are required unless otherwise indicated in the Table of Validation Tests.

2.2 Flight test data

2.2.1 Data which exhibit rapid variations of the measured parameters may require engineering judgment when making assessments of simulator validity. Such judgment 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 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

2.3 Parameters, tolerances, and flight conditions

2.3.1 The Table of Validation Tests in Appendix 1 describes the parameters, tolerances, and flight conditions for 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:

(a) for parameters that have units of per cent, or parameters normally displayed in the cockpit in units of per cent (e.g. N1, N2, engine torque or power), then a percentage tolerance should be interpreted as an absolute tolerance unless otherwise specified (i.e. for an observation of 50% N1 and a tolerance of 5%, the acceptable range should be from 45% to 55%); and

(b) for parameters not displayed in units of per cent, a tolerance expressed only as a percentage should be interpreted as the percentage of the current reference value of that parameter during the test, except for parameters varying around a zero value for which a minimum absolute value should be agreed by CAD.

2.3.2 If a flight condition or operating condition is shown which does not apply to the qualification level sought, it should be disregarded. Simulator results should be labelled using the tolerances and units given.

2.4 Flight condition verification

2.4.1 When comparing the parameters listed to those of the helicopter, sufficient data should also be provided to verify the correct flight condition. All airspeed values should be clearly annotated as to indicated, calibrated, true airspeed, etc. and like values used for comparison.

2.4.2 Where the tolerances have been replaced by 'correct trend and magnitude' (CT&M), the FSTD should be tested and assessed as representative of the helicopter to the satisfaction of the HK CAD. To facilitate future evaluations, sufficient parameters should be recorded to establish a reference. For the initial qualification of FNPTs no tolerances are to be applied and the use of CT&M is to be assumed throughout.

2.5 Table of FSTD validation tests

2.5.1 A number of tests within the QTG have had their requirements reduced to CT&M for initial evaluations thereby avoiding the need for specific flight test data. Where CT&M is used, 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 evaluation.

2.5.2 However, the use of CT&M is not to be taken as an indication that certain areas of simulation can be ignored. It is imperative that the specific characteristics are present, and incorrect effects would be unacceptable.

2.5.3 In all cases the tests are intended for use in recurrent evaluations at least to ensure repeatability.

Note 1: It is accepted that tests and associated tolerances should only apply to a level 1 FTD if that system or flight condition is simulated.

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

CHAPTER 5 APPENDIX 1

FSTD VALIDATION TESTS

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
														For FNPT CT&M should be used for initial evaluations. The tolerances should be applied for recurrent evaluations. It is accepted that tests and associated tolerances only apply to a level 1 FTD if that system or flight condition is simulated.
1. PERFORMANCE														
a. Engine Assessment														
(1) Start operations (i) Engine start and acceleration (transient)	Light off time ± 10% or ±1 s Torque ± 5% Rotor speed ± 3% Fuel flow ± 10% Gas generator speed ± 5% Power turbine speed ± 5% Turbine gas temp. ± 30°C	Ground rotor brake used/Not used	CT&M	✓	✓	✓	CT&M	✓	✓		✓	✓	✓	Time histories of each engine from initiation of start sequence to steady state idle and from steady state idle to operating RPM. Tolerance to be only applied in the validity domain of the engine parameter sensors.
(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°C	Ground	CT&M	✓	✓	✓	CT&M	✓	✓		✓	✓	✓	Present data for both steady state idle and operating RPM conditions. May be snapshot tests.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(2) Power turbine speed trim	± 10% of total change of power turbine speed or ± 0·5% rotor speed	Ground	CT&M	✓	✓	✓	CT&M	✓	✓		✓	✓	✓	Time history of engine response to trim system actuation (both directions).
(3) Engine & rotor speed governing	Torque ± 5% Rotor speed ± 1·5%	Climb and descent	CT&M	✓	✓	✓	CT&M	✓	✓	✓	✓	✓	✓	Collective step inputs. Can be conducted with climb & descent performance tests.
b. Ground Operations														
(1) Minimum radius turn	Helicopter turn radius ± 3 ft (0·9 m) or 20%	Ground		✓	✓	✓								If differential braking is used, brake force should be set at the helicopter test flight value.
(2) Rate of turn vs pedal deflection or nosewheel angle	Turn rate (left and right) ± 10% or 2° /s	Ground		✓	✓	✓								Without usage of wheel brakes.
(3) Taxi	Pitch angle ± 1·5° Torque ± 3% Longitudinal control position ± 5% Lateral control position ± 5% Directional control position ± 5% Collective control position ± 5%	Ground	CT&M	✓	✓	✓								Control position & pitch angle during ground taxi for a specific ground speed & direction, and density altitude.
(4) Brake effectiveness	Time : ± 10%or ±1 s and Distance : ± 10%or ± 30 m (100 ft)	Ground	CT&M	✓	✓	✓		CT&M	CT&M					Record data until full stop.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
c. Take-off														
(1) All engines	Airspeed ± 3 kt Altitude ± 20 ft (6·1 m) Torque ± 3% Rotor speed ± 1·5% Pitch angle ± 1·5° Bank angle ± 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	✓	✓	✓	C T & M	✓	✓		✓	✓	✓	Time history of take-off flight path as appropriate to helicopter model simulated [running take-off for FFS level B & FTD level 2. Take-off from a hover for FFS level C & D or FTD level 3]. In addition to the airspeed the ground speed should be taken as reference with the same tolerance of ±3 kts until the airspeed is clearly readable. For FFS level B and FTD level 2, criteria apply only to those segments at airspeeds above effective translational lift. Record data to at least 200 ft (61 m) AGL/V_Y whichever comes later.
(2) OEI continued take-off	See 1.c.(1) above for tolerances and flight conditions	Take-off & initial climb	C T & M	✓	✓	✓	C T & M	✓	✓		✓	✓	✓	Time history of take-off flight path as appropriate to helicopter model simulated. Record data to at least 200 ft (61 m) AGL/V_Y whichever comes later.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(3) OEI rejected take-off	Airspeed ± 3 kt Altitude ±20 ft (6·1 m) Torque ±3% Rotor speed ±1·5% Pitch angle ± 1·5° Bank angle ± 1·5° Heading ±2° Longitudinal control position ± 10% Lateral control position ± 10% Directional control position ±10% Collective control position ±10% Distance: ± 7·5% or ± 30 m (100 ft)	Ground/take-off	CT&M	CT&M	✓	✓		✓	✓			✓	✓	Time history from the take-off point to touch down. Test conditions near limiting performance as per aircraft manual. In addition to the airspeed the ground speed should be taken as reference with the same tolerance of ± 3 kts until the airspeed is clearly readable.
d. Hover Performance	Torque ± 3% Pitch angle ±1·5° Bank angle ±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) Stability augmentation on or off	CT&M	✓	✓	✓	CT&M	✓	✓		✓	✓	✓	Light and heavy gross weights. May be snapshot tests.
e. Vertical Climb Performance	Vertical velocity ± 100 fpm (0.50 m/s) or 10% Directional control position ±5% Collective control position ±5%	From OGE hover Stability augmentation on or off	CT&M	✓	✓	✓	CT&M	✓	✓		✓	✓	✓	Light and heavy gross weights. May be snapshot tests.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
f. Level Flight Performance and Trimmed Flight Control Position	Torque ± 3% Pitch angle ± 1.5° Sideslip angle ± 2° Longitudinal control position ± 5% Lateral control position ± 5% Directional control position ±5% Collective control position ±5%	Cruise stability Stability augmentation on or off	CT&M	✓	✓	✓	CT&M	✓	✓	✓	✓	✓	✓	Two combination of gross weight/cg and at least two speeds (including V_y and maximum cruise speed) within the flight envelope. May be snapshot tests. For FNPT level 1 changes in Cg are not required. For FNPT (any level), only one stability augmentation case is required.
g. Climb Performance and Trimmed Flight Control Position	Vertical velocity ± 100 fpm (0·50 m/s) or 10% Pitch angle ± 1·5° Sideslip angle ± 2° Longitudinal control position ± 5% Lateral control position ± 5% Directional control position ±5% Collective control position ±5% Speed ±3 kts	All engines operating OEI Stability augmentation on or off	CT&M	✓	✓	✓	CT&M	✓	✓	✓	✓	✓	✓	Two gross weight/cg combinations. Data presented at relevant climb power conditions. The achieved measured vertical velocity of the FSTD cannot be less than the appropriate approved AFM values. For FNPT level 1 changes in Cg are not required. May be snapshot tests.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
h. Descent														
(1) Descent performance and trimmed flight control position	Torque ± 3% Pitch angle ± 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 (5 m/s) rate of descent (R/D) at normal approach speed. Stability augmentation on or off	C T & M	✓	✓	✓	C T & M	✓	✓	✓	✓	✓	✓	Two gross weight/CG combinations. For FNPT level 1 changes in CG are not required. May be snapshot tests.
(2) Autorotation performance and trimmed flight control position	Vertical velocity ± 100 fpm (0·50 m/s) or 10% Rotor speed ± 1·5% Pitch angle ± 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 or off	C T & M	✓	✓	✓		✓	✓	✓	✓	✓	✓	Two gross weight/CG combinations. Rotor speed tolerance only applies if collective control position is fully down. Speed sweep from approximately 50 kts to at least maximum glide distance airspeed. May be a series of snapshot tests.
i. Auto-rotational Entry	Torque ± 3% Rotor speed ± 3% Pitch angle ± 2° Bank angle ± 3° Heading ± 5° Airspeed ± 5 kt Altitude ± 20 ft (6·1 m)	Cruise or climb	C T & M	✓	✓	✓		✓	✓	✓	✓	✓	✓	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.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
j. Landing														
(1) All engines	Airspeed ± 3 kt Altitude ±20 ft (6·1 m) Torque ±3% Rotor speed ±1.5% Pitch angle ± 1·5° Bank angle ± 1·5° Heading ±2° Longitudinal control position ± 10% Lateral control position ± 10% Directional control position ±10% Collective control position ±10%	Approach and landing	CT&M	✓	✓	✓	CT&M	✓	✓	✓	✓	✓	✓	Time history of approach and landing profile as appropriate to helicopter model simulated (running landing for FFS level B/FTD level 2, approach to a hover and to touch down for FFS level C & D/FTD level 3). For FFS levels A & B, and FTD levels 1 and 2, & FNPT level II and III criteria apply only to those segments at airspeeds above effective translational lift. In addition to the airspeed, the ground speed should be taken as reference with the same tolerance of ± 3 kts at speeds below which airspeed is not clearly readable.
(2) OEI	See 1j(1) above for tolerances	Approach and landing	CT&M	✓	✓	✓	CT&M	✓	✓		✓	✓	✓	Include data for both Category A & Category B approaches & landings as appropriate to the helicopter model being simulated. For FFS levels A & B, and FTD levels 1 and 2, and FNPT level II and III criteria apply to only those segments at airspeeds above effective translational lift.
(3) Balked landing/missed approach	See 1j(1) above for tolerances	Approach, OEI		✓	✓	✓		✓	✓		✓	✓	✓	From a stabilised approach at the landing decision point (LDP).

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(4) Autorotational landing with touch down	Airspeed ± 3 kts Torque ± 3% Rotor speed ± 3% Altitude ± 20 ft (6·1 m) Pitch angle ± 2° Bank angle ± 2° Heading ± 5° Longitudinal control position ± 10% Lateral control position ± 10% Directional control position ± 10% Collective control position ± 10%	Approach and touch down			✓	✓		CT&M	CT&M					Time history of autorotational deceleration and touch down from a stabilised auto- rotational descent.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
2. HANDLING QUALITIES														
a. Control System Mechanical Characteristics														
(1) Cyclic	Breakout ± 0.25 lb (0·112 daN) or 25% Force ± 0.5 lb (0·224 daN) or 10%	Ground, static Trim on and off Friction off Stability augmentation on and off	✓	✓	✓	✓	CT&M	✓	✓	✓	✓	✓	✓	Uninterrupted control sweeps. This test is not required for aircraft hardware modular controllers. Cyclic position vs. force should be measured at the control. An alternate method acceptable to the competent authority in lieu of the test fixture at the controls would be to instrument the FSTD in an equivalent manner to the flight test 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	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(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 and off Friction off Stability augmentation on/off	✓	✓	✓	✓	CT&M	✓	✓	✓	✓	✓	✓	Uninterrupted control sweeps. This test is not required for aircraft hardware modular controllers. Collective and pedal position vs. force should be measured at the control. An alternate method acceptable to the competent authority in lieu of the test fixture at the controls would be to instrument the FSTD in an equivalent manner to the flight test 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.
(3) Brake pedal force vs. position	± 5 lb (2·224 daN) or 10%	Ground, static	CT&M	✓	✓	✓	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	✓	✓	✓	✓	CT&M	✓	✓	✓	✓	✓	✓	Tolerance applies to recorded value of trim rate.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(5) Control dynamics (all axes)	± 10% of time for first zero crossing and ± 10 (N+1)% ofperiod thereafter ± 10% amplitude offirst overshoot ± 20% of amplitude of 2nd and subsequent overshoots greater than 5% of initial displacement ± 1 overshoot	Hover and cruise Trim on Friction off Stability augmentation on and off		✓	✓	✓		C T & M	✓					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.
(6) Free play	± 0.10 in (2·5 mm)	Ground, static Friction off		✓	✓	✓		✓	✓					Applies to all controls.
b. Low Airspeed Handling Qualities														
(1) Trimmed flight control positions	Torque ± 3% Pitch angle ± 1·5° Bank angle ± 2° Longitudinal control position ± 5% Lateral control position ± 5% Directional control position ±5% Collective control position ±5%	Translational flight IGE. Sideways, rearward and forward Stability augmentation on or off			✓	✓		✓	✓					Several airspeed increments to translational airspeed limits and 45 kts forward. May be a series of snapshot tests.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(2) Critical azimuth	Torque ± 3% Pitch angle ± 1·5° Bank angle ± 2° Longitudinal control position ± 5% Lateral control position ± 5% Directional control position ±5% Collective control position ±5%	Stationary hover Stability augmentation on or off			✓	✓		✓	✓					Present data for three relative wind directions (including the most critical case) in the critical quadrant. May be a snapshot test. Precise wind measurement is very difficult and simulated wind obtained by translational flight in calm weather condition (no wind) is preferred in order to control precisely flight conditions by using groundspeed measurement (usually GPS). In this condition, it would be more practical to realise this test with tests 2.b(1) in order to ensure consistency between critical azimuth and other directions (forward, sideward and rearward).
(3) Control response														
(i) Longitudinal	Pitch rate ± 10% or ± 2°/s Pitch angle change ± 10% or ± 1·5°	Hover stability augmentation on and off			✓	✓		CT&M	✓					Step control input. Off axis response must show correct trend for unaugmented cases.
(ii) Lateral	Roll rate ± 10% or ± 3°/s Bank angle change ± 10% or ± 3°	Hover stability augmentation on and off			✓	✓		CT&M	✓					Step control input. Off axis response must show correct trend for unaugmented cases.
(iii) Directional	Yaw rate ± 10% or ± 2°/s Heading change ± 10% or ± 2°	Hover stability augmentation on and off			✓	✓		CT&M	✓					Step control input. Off axis response must show correct trend for unaugmented cases.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(iv) Vertical	Normal acceleration ± 0·1 g	Hover stability augmentation on and off			✓	✓		C T & M	✓					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°/s Pitch angle change ± 10% or ± 1.5°	Cruise Stability augmentation on and off		✓	✓	✓		C T & M	✓					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 and Autorotation Stability augmentation on or off	✓	✓	✓	✓	C T & M	✓	✓					Minimum of two speeds on each side of the trim speed. May be a snapshot test.
(3) Dynamic stability														
(i) Long term response	± 10% of calculated period ± 10% of time to ½ or Double amplitude or ± 0·02 of damping ratio	Cruise Stability augmentation off		✓	✓	✓		C T & M	✓		✓	✓	✓	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 angle or ± 2°/s pitch rate ± 0·1 g normal acceleration	Cruise or climb Stability augmentation on and off		✓	✓	✓		C T & M	✓		✓	✓	✓	Two airspeeds. Time history to validate short helicopter response due to control pulse input. Check to stop 4 seconds after completion of input.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(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 or off Left and right turns	C T & M	✓	✓	✓	C T & M	✓	✓					Force may be a cross plot for irreversible systems. Two airspeeds. May be a series of snapshot tests. Approximately 30° and 45° bank angle data should be presented.
(5) Landing gear operating time	± 1 s	Take-off (retraction) Approach (extension)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
d. Lateral & Directional Handling Qualities.														
(1) Control response (i) Lateral	Roll rate ± 10% or ± 3°/s Bank angle change ± 10% or ± 3°	Cruise stability augmentation on and off		✓	✓	✓		C T & M	✓	✓	✓	✓	✓	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.
(ii) Directional	Yaw rate ± 10% or 2^0 /s. Yaw angle change ± 10% or ± 2^0	Cruise stability augmentation on and off		✓	✓	✓		C T & M	✓	✓	✓	✓	✓	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.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(2) Directional static stability	Lateral control position ±10% of change from trim or ±0·25 in (6·3 mm) , or lateral control force ± 0·5 lb (0·224 daN) or ± 10% Bank angle ±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 ± 0·25 in (6·3 mm)	Cruise or Climb and descent Stability augmentation on or off	C T & M	✓	✓	✓	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.
(3) Dynamic lateral and directional stability														
(i) Lateral-directional oscillations	±0·5 s or ±10% of period ±10% of time to ½ or double amplitude or ±0.02 of damping ratio ±20% or ±1 s of Time difference between peaks of bank and sideslip	Cruise or climb Stability augmentation on and off	C T & M	✓	✓	✓	C T & M	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 s	Cruise or climb Stability augmentation on and off	C T & M	✓	✓	✓	C T & M	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.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(iii) Adverse/ proverse yaw	Correct trend on side slip ± 2°	Cruise or climb Stability augmentation on and off	C T & M	✓	✓	✓		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	N/A	Take-off, cruise and landing	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
(2) Tests to demonstrate other atmospheric models to support the required training						✓			✓			✓	✓	
4. MOTION SYSTEM **														
a. Motion Envelope														
(1) Pitch		N/A												
(i) Displacement ± 20^0 ± 25^0			 ✓	 ✓	 ✓	 ✓								
(ii) Velocity ± 15^0/s ± 20^o/s			 ✓	 ✓	 ✓	 ✓								
(iii) Acceleration ± 75^o/s² ± 100^o/s²			 ✓	 ✓	 ✓	 ✓								

** 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	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(2) Roll		N/A												
(i) Displacement $\pm 20^{0}$ $\pm 25^{0}$			✓	✓	✓	✓								
(ii) Velocity $\pm 15^{0}$/s $\pm 20^{o}$/s			✓	✓	✓	✓								
(iii) Acceleration $\pm 75^{o}$/s $\pm 100^{o}$/s			✓	✓	✓	✓								
(3) Yaw		N/A												
(i) Displacement $\pm 25^{0}$				✓	✓	✓								
(ii) Velocity $\pm 15^{0}$/s $\pm 20^{o}$/s			✓	✓	✓	✓								
(iii) Acceleration $\pm 75^{o}/s^2$ $\pm 100^{o}/s^2$			✓	✓	✓	✓								
(4) Vertical		N/A												
(i) Displacement ± 22 in ± 34 in			✓	✓	✓	✓								
(ii) Velocity ± 16 in/s ± 24 in/s			✓	✓	✓	✓								
(iii) Acceleration ± 0·6 g ± 0·8 g			✓	✓	✓	✓								

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(5) Lateral		N/A												
(i) Displacement ± 26 in ± 45 in				✓	✓	✓								
(ii) Velocity ± 20 in/s ± 28 in/s				✓	✓	✓								
(iii) Acceleration ± 0·4 g ± 0·6 g				✓	✓	✓								
(6) Longitudinal		N/A												
(i) Displacement ± 27 in ± 34 in				✓	✓	✓								
(ii) Velocity ± 20 in/s ± 28 in/sec				✓	✓	✓								
(iii) Acceleration ± 0·4 g ± 0·6 g				✓	✓	✓								
(7) Initial rotational acceleration rate All axes ± 225^0/s²/s ± 300^0/s²/s		N/A	✓	✓	✓	✓								All relevant rotational axes

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(8) Initial linear acceleration rate		N/A												
(i) Vertical ± 4 g/s ± 6 g/s			✓	✓	✓	✓								
(ii) Lateral ± 2 g/s ± 3 g/s				✓	✓	✓								
(iii) Longitudinal ± 2 g/s ± 3 g/s				✓	✓	✓								
b. **Frequency Response Band, Hz** 0·1 to 1·0 1·1 to 3·0	Phase amplitude deg ratio Db 0 to -20 ± 2 0 to -40 ± 4	N/A		✓	✓	✓								All six axis
c. **Leg Balance** or Parasitic acceleration	1·5 deg 0·02 g or 3 deg/s² (peak)	N/A		✓	✓	✓								The phase shift between a datum jack & any other jack should be measured using a heave (vertical) signal of 0·5 Hz at ± 0·25 g. The acceleration in the other five axes should be measured using a heave (vertical) signal of 0.5 Hz at ± 0·1 g.
d. **Turn Around**	0·05 g			✓	✓	✓								The motion base should 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 should be measured.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
e. Characteristic vibrations/buffet (1) Vibrations - tests to include 1/rev and n/rev vibrations where n is the number of rotor blades	+ 3 / - 6 db or ± 10% of nominal vibration level in flight cruise & correct trend (see comment)	On ground (idle flt nr); low & high speed; Level flight; Climb/descent (including vertical climb; Autorotation; Steady turns)				✓								Correct trend refers to a comparison of vibration amplitudes between different manoeuvres. E.g. If the 1/rev vibration amplitude in the helicopter is higher during steady state turns than in level flight this increasing trend should be demonstrated in the FFS.
(2) Buffet A test with recorded results is required for characteristic buffet motion which can be sensed in the cockpit	+ 3 / - 6 db or ± 10% of nominal vibration level in flight cruise & 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	N/A			✓	✓	✓								

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
5. VISUAL SYSTEM Note: refer to the table of functions & subjective tests for additional visual tests.														
a. Visual ground segment (VGS)	Near end. The lights computed to be visible should be visible in the FSTD. Far end : ± 20% of the computed VGS	Trimmed in landing configuration at 100 ft landing gear height above touch down zone on glide slope with 300 m or 350 m RVR	✓	✓	✓	✓								Visual ground segment. This test is designed to assess items impacting the accuracy of the visual scene presented to a pilot at DH on an ILS approach. Those items include: 1) RVR; 2) glideslope (G/S) and localiser modelling accuracy (location and slope) for an ILS; 3) for a given weight, configuration and speed representative of a point within the helicopter's operational envelope for a normal approach and landing.
Visual ground segment (VGS) (continued)		Trimmed in landing configuration at 200 ft landing gear height above touch down zone on glide slope with 500 m RVR						✓	✓		✓	✓	✓	If non-homogenous fog is used, the vertical variation in horizontal visibility should be described and be included in the slant range visibility calculation used in the VGS computation. The downward field of view may be limited by the aircraft structure or the visual system display, whichever is less.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
b. Display system tests														
1. (a) Continuous cross-cockpit visual field of view	Continuous visual field of view providing each pilot with 180º horizontal and 60º vertical field of view. Horizontal FOV: not less than a total of 176º (including not less than 75º measured either side of the centre of the design eye point). Vertical FOV: not less than a total of 56º measured from the pilot's and co-pilot's eye point.	N/A				✓								Field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5 ° squares. Installed alignment should be confirmed in a statement of compliance. The 75º minimum allows an offset either side of the horizontal field of view if required for the intended use.
1. (b) Continuous cross-cockpit visual field of view	Continuous visual field of view providing each pilot with 150º horizontal and 60º vertical field of view. Horizontal FOV: not less than a total of 146º (including not less than 60º measured either side of the centre of the design eye point). Vertical FOV: not less than a total of 56º measured from the pilot's and co-pilot's eye point.	N/A							✓			✓	✓	Field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5 ° squares. Installed alignment should be confirmed in a statement of compliance. The 60º minimum allows an offset either side of the horizontal field of view if required for the intended use.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
1. (c) Continuous cross-cockpit visual field of view	Continuous visual field of view providing each pilot with 150º horizontal and 40º vertical field of view. Horizontal FOV: not less than a total of 146º (including not less than 60º measured either side of the centre of the design eye point). Vertical FOV: not less than a total of 36 º measured from the pilot's and co-pilot's eye point.	N/A			✓			✓			✓		✓	Field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5° squares. Installed alignment should be confirmed in a statement of compliance. The 60º minimum allows an offset either side of the horizontal field of view if required for the intended use.
1. (d) Visual field of view	Visual system providing each pilot with 75º horizontal and 40º vertical field of view	N/A		✓										
	Visual system providing each pilot with 45º horizontal and 30º vertical field of view		✓											
2. Occulting demonstrate 10 levels of occulting through each channel of the system	Demonstration model	N/A			✓	✓		✓	✓		✓	✓	✓	

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
3. System geometry	5° even angular spacing within ± 1° as measured from either pilot eye- point, and within 1·5° for adjacent squares.	N/A	✓	✓	✓	✓		✓	✓		✓	✓	✓	System geometry should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5° squares with lightpoints at the intersections. The operator should demonstrate that the angular spacing of any chosen 5° square and the relative spacing of adjacent squares are within the stated tolerances. The intent of this test is to demonstrate local linearity of the displayed image at either pilot eye- point.
4. Surface contrast ratio	Not less than 5:1 Demonstration model				✓	✓		✓	✓		✓	✓	✓	Surface contrast ratio should be measured using a raster drawn test pattern filling the entire visual scene (all channels). The test pattern should consist of black and white squares, no larger than 10 ° and no smaller than 5º per square with a white square in the centre of each channel. Measurement should be made on the centre bright square for each channel using a 1 ° spot photometer. This value should have a minimum brightness of 7 cd/m2 (2 ft- Lamberts). Measure any adjacent dark squares. The contrast ratio is the bright square value divided by the dark square value. *Note: during contrast ratio testing, FSTD aft-cab and cockpit ambient light levels should be zero.*

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
5. Highlight brightness	Not less than 20 cd/m^2 (6 ft-Lamberts) from the display measured at the design eye point	N/A			✓	✓								Highlight brightness should be measured by maintaining the full test pattern described in paragraph 5.b.3 above, superimposing a highlight on the centre white square of each channel and measuring the brightness. Lightpoints are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable. For raster only display devices the highlight brightness is measured using a white raster and measuring the average brightness in each channel.
	Not less than 17 cd/m^2 (5 ft-Lamberts) from the display measured at the design eye point							✓	✓		✓	✓	✓	
6. Vernier resolution	Not greater than 3 arc minutes	N/A			✓	✓		✓	✓		✓	✓	✓	Vernier resolution should be demonstrated by a test of objects shown to occupy the required visual angle in each visual display used on a scene from the pilot's eye-point.
7. Lightpoint size	Not greater than 6 arc minutes	N/A			✓	✓								Lightpoint size should be measured using a test pattern consisting of a centrally located single row of lightpoints reduced in length until modulation is just discernible in each visual channel. A row of 40 lights in the case of 6 arc minutes (30 lights in the case of 8 arc minutes) will form a 4° angle or less.
	Not greater than 8 arc minutes	N/A		✓				✓	✓		✓	✓	✓	
	Demonstration model													

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
8. Lightpoint contrast ratio	Not less than 25:1	N/A			✓	✓		✓	✓					Lightpoint contrast ratio should be measured using a test pattern demonstrating a 1º area filled with lightpoints (i.e. lightpoint modulation just discernible) and should be compared to the adjacent background. *Note: during contrast ratio testing, FSTD aft-cab and cockpit ambient light levels should be zero.*
	Not less than 5:1										✓	✓	✓	
	Demonstration model													
6 FSTD SYSTEMS														
a Visual, Motion and Cockpit Instrument Response														
(1) Transport delay	*200 ms or less after control movement*						✓			✓				*One test is required in each axis (pitch, roll & yaw)*
	150 ms or less after control movement		✓	✓				✓			✓	✓	✓	
	100 ms or less after control movement				✓	✓			✓					

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(1) Transport delay (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 (where applicable), 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. 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.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
OR alternative test:														
Latency (2) Visual, motion (where fitted), instrument system response to an abrupt pilot controller input, compared to helicopter response for a similar input.	150 ms or less after helicopter response’	Climb, cruise and descent	✓	✓										One test is required in each axis (pitch, roll and yaw) for each of the flight conditions, compared to helicopter data. 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.
Latency (continued)	100 ms or less after helicopter response	Climb, cruise, descent and hover (hover FFS only)			✓	✓			✓					The test to determine compliance 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 (where applicable), the output from 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 competent authority. The test results in a comparison of a recording of the simulator's response with actual helicopter data.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
b Sound														
(1) Realistic engine and rotor sounds	N/A									✓				Statement of Compliance or demonstration of representative sounds.
(2) Establish amplitude & frequency of cockpit sounds	N/A	On ground all engines on and Hover and Straight and level flight	C T & M	C T & M	C T & M			C T & M	C T & M		C T & M	C T & M	C T & M	Test results should show a comparison of the amplitude & frequency content of the sounds against data recorded at the initial FSTD qualification. No reference data are required for initial FSTD qualification.
(2) Establish amplitude & frequency of cockpit sounds (continued)														All tests in this section should be presented using an unweighted 1/3-octave band format from band 17 to 42 (50 Hz to 16-kHz). A minimum 20 second average should be taken at the location corresponding to the helicopter data set. The helicopter and FSTD results should be produced using comparable data analysis techniques.
(i) Ready for engine start	±5 dB per 1/3 octave band	Ground				✓								Normal condition prior to engine start. The APU should be on if appropriate.
(ii) All engines at idle a) rotor not turning (If applicable) b) rotor turning	±5 dB per 1/3 octave band	Ground				✓								Normal condition prior to lift- off.
(iii) Hover	±5 dB per 1/3 octave band	Hover				✓								
(iv) Climb	±5 dB per 1/3 octave band	En-route climb				✓								Medium altitude.

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL											COMMENTS
			FFS				FTD			FNPT				
			A	B	C	D	1	2	3	I	II	III	MCC	
(v) Cruise	±5 dB per 1/3 octave band	Cruise				✓								Normal cruise configuration.
(vi) Final approach	±5 dB per 1/3 octave band	Landing				✓								Constant airspeed, gear down.
(3) Special cases	n/a					CT&M								Special cases identified as particularly significant to the pilot, important in training, or unique to a specific helicopter type or variant.
(4) FSTD background noise	Initial evaluation: n/a Recurrent evaluation: ±3 dB per 1/3 octave band compared to initial evaluation					✓								Results of the background noise at initial qualification should be included in the QTG document and approved by the qualifying authority. The simulated sound should be evaluated to ensure that the background noise does not interfere with training. The measurements are to be made with the simulation running, the sound muted and a dead cockpit.
(5) Frequency response	Initial evaluation: n/a Recurrent evaluation: cannot exceed ± 5 dB on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.				✓	✓								Only required if the results are to be used during recurrent evaluations. The results should be acknowledged by the competent authority at initial qualification.

CHAPTER 5 APPENDIX 2

SUPPLEMENTAL INFORMATION ON VALIDATION TESTS

1. Control Dynamics

1.1 General

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

1.1.2 Recordings such as free response to a pulse or step function are classically used to estimate the dynamic properties of electromechanical systems. In any case, the dynamic properties can only be estimated since the true inputs and responses are also only estimated. Therefore, it is imperative that the best possible data be collected since close matching of the FSTD control loading system to the helicopter systems is essential. The required dynamic control checks are indicated in paragraph 2.b(1) to (3) of the table of FSTD validation tests.

1.1.3 For initial and upgrade evaluations, control dynamics characteristics should be measured at and recorded directly from the flight controls. This procedure is usually accomplished by measuring the free response of the controls using a step input or pulse input to excite the system. The procedure should be accomplished in relevant flight conditions and configurations.

1.1.4 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 FSTDs requiring static and dynamic tests at the controls, special test fixtures should not be required during initial and upgrade evaluations if the MQTG shows both test fixture results and the results of an alternate approach, such as computer plots which were produced concurrently and show satisfactory agreement. Repeat of the alternate method during the initial evaluation would then satisfy this test requirement.

1.2 Control dynamics evaluation

1.2.1 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 FSTD control loading, criteria are needed that clearly define the interpretation of the measurements and the tolerances to be applied. Criteria are needed for underdamped, critically damped, and overdamped systems. In the case of an underdamped system will 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.

1.2.2 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 underdamped and critically damped cases are as follow

1.3 Underdamped response

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

1.3.2 The damping tolerance should be applied to overshoots on an individual basis. Care should be taken when applying the tolerance to small overshoots since the significance of such overshoots becomes questionable. Only those overshoots larger than 5% of the total initial displacement should be considered. The residual band, labelled $T(A_d)$ in Figure 1 is ± 5% of the initial displacement amplitude A_d from the steady state value of the oscillation. Only oscillations outside the residual band are considered significant. When comparing FSTD data to helicopter data, the process should begin by overlaying or aligning the FSTD 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 FSTD should show the same number of significant overshoots to within one when compared against the helicopter data. This procedure for evaluating the response is illustrated in Figure 1 below.

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

1.3.4 *Special considerations*. Control systems, which exhibit characteristics other than classical overdamped or underdamped responses should meet specified tolerances. In addition, special consideration should be given to ensure that significant trends are maintained.

1.4 Tolerances

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

$T(P_0)$	± 10% of P_0
$T(P_2)$	± 30% of P_2
$T(P_n)$	± 10(n+1)% of P_n
$T(A_n)$	± 10% of A_1
$T(A_d)$	± 5% of A_d = residual band

Significant overshoots, first overshoot and ± 1 subsequent overshoots

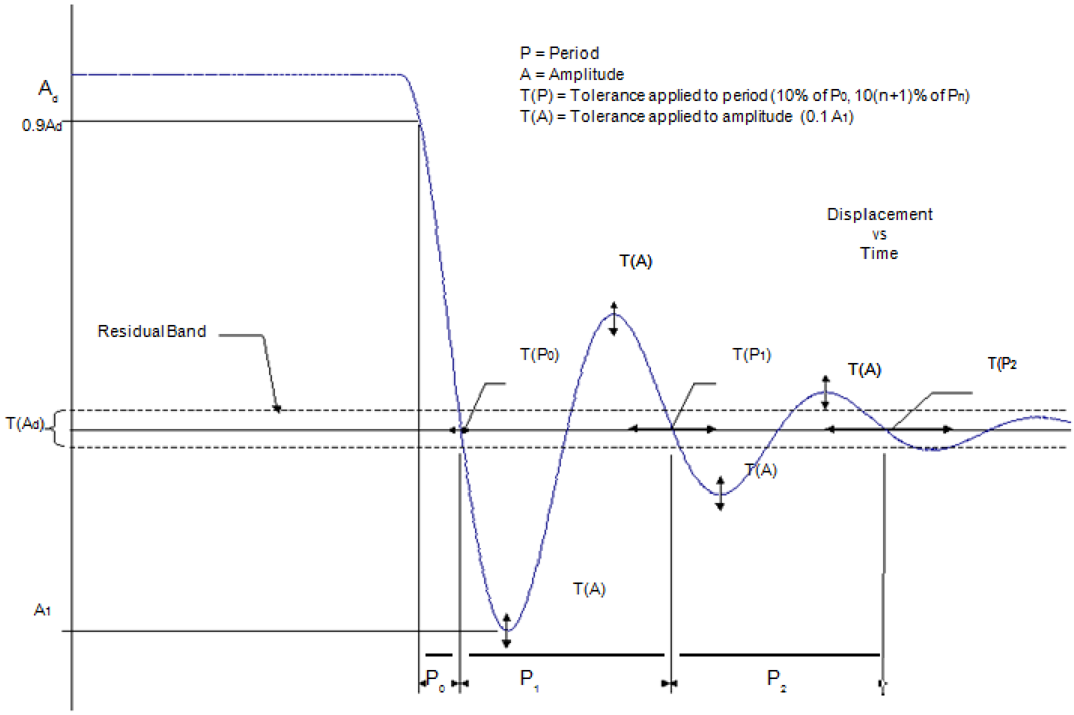

Figure 1: Underdamped step response

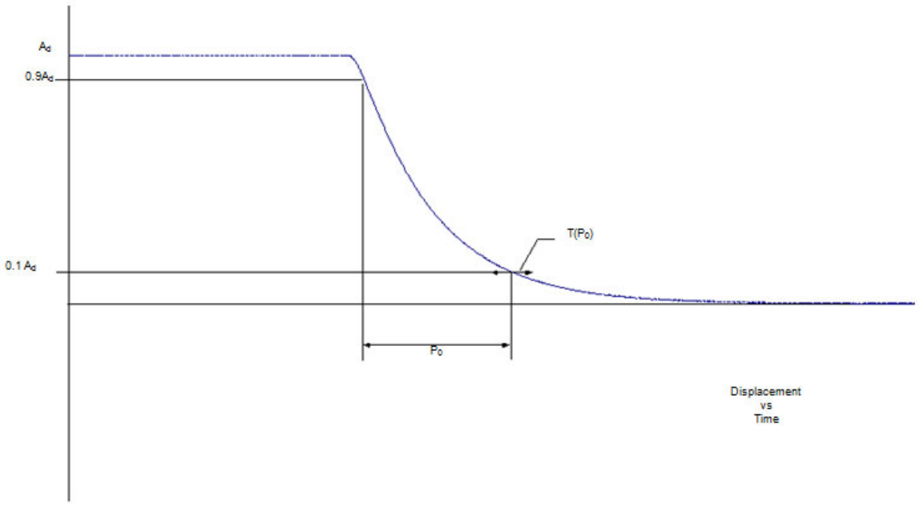

Figure 2: Critically damped step response

1.5 Alternate method for control dynamics evaluation

1.5.1 An alternate means for validating control dynamics for aircraft with hydraulically powered flight controls and artificial feel systems is by the measurement 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 flight and ground conditions.

1.5.2 Static test – slowly move the control such that approximately 100 s 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.

1.5.3 Slow dynamic test – achieve a full sweep in approximately 10 s.

1.5.4 Fast dynamic test – achieve a full sweep in approximately 4 s.

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

1.6 Tolerances

1.6.1 Static test, see paragraph 2.a(1), (2), and (3) of the table of FSTD validation tests.

1.6.2 Dynamic test – ± 0.9 daN (2 lbs) or ± 10% on dynamic increment above static test.

1.6.3 CAD 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 aircraft with reversible control systems. Hence, each case should be considered on its own merit on an ad hoc basis. Should the HK CAD find that alternative methods do not result in satisfactory performance, then more conventionally accepted methods should be used.

2. Ground effect

2.1 For an FSTD to be used for lift-off and touch down it should faithfully reproduce the aerodynamic changes which occur in ground effect. The parameters chosen for FSTD validation should be indicative of these changes. The primary validation parameters for characteristics in ground effect are:

2.1.1 longitudinal, lateral, directional and collective control positions;

2.1.2 torque required for hover;

2.1.3 height;

2.1.4 airspeed;

2.1.5 pitch angle; and

2.1.6 bank angle.

2.2 A dedicated test should be provided to validate the aerodynamic ground effect characteristics. The selection of the test method and procedures to validate ground effect is at the option of the organisation performing the flight tests; however, the flight test should be performed with enough duration near the ground to validate sufficiently the ground-effect model.

2.3 Acceptable tests for validation of ground effect include the following:

2.3.1 Level fly-bys: these should be conducted at a minimum of three altitudes within the ground effect, including one at no more than 10% of the rotor diameter above the ground, one each at approximately 30% and 70% of the rotor diameter where height refers to main gear above the ground. In addition, one level-flight trim condition should be conducted out of ground effect, e.g. at 150% of rotor diameter. Level 2/3 FTDs and II/III FNPTs may use methods other than the level fly-by method.

2.3.2 Shallow approach landing: this should be performed at a glideslope of approximately one degree with negligible pilot activity until flare.

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

3. Motion system

3.1 General

3.1.1 Pilots use continuous information signals to regulate the state of the helicopter. In concert with the instruments and outside-world visual information, whole-body motion feedback is essential in assisting the pilot to control the helicopter's dynamics, particularly in the presence of external disturbances. The motion system should therefore meet basic objective performance criteria, as well as being subjectively tuned at the pilot's seat position to represent the linear and angular accelerations of the helicopter during a prescribed minimum set of manoeuvres and conditions. Moreover, the response of the motion cueing system should be repeatable.

3.2 Motion system checks

3.2.1 The intent of tests as described in the table of FSTD validation tests, paragraph 4.a: motion envelope, 4.b: frequency response band, 4.c: leg balance and 4.d: turn around, is to demonstrate the performance of the motion system hardware, and to check the integrity of the motion set-up with regard to calibration and wear. These tests are independent of the motion cueing software and should be considered as robotic tests.

3.3 Motion cue repeatability testing

3.3.1 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 that occurs in an aircraft for the same tasks, motion systems should 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 should be accomplished at least annually using the following testing procedure:

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

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

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

(d) 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 CG 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.*

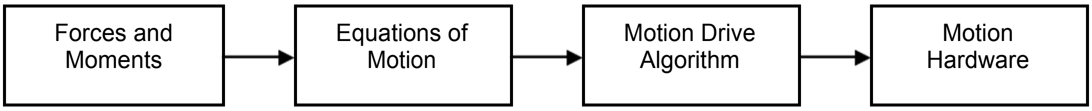

Figure 3

Linear Accelerations or Angular Velocities

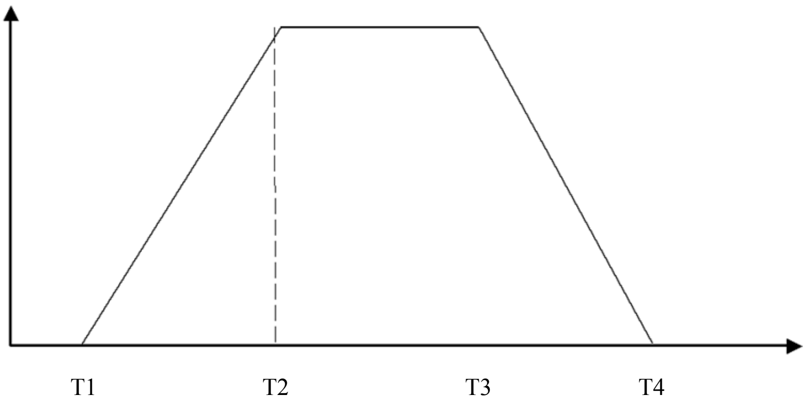

Figure 4

3.4 Motion vibrations

3.4.1 Presentation of results. The characteristic motion vibrations are a means to verify that the FSTD can reproduce the frequency content of the helicopter when flown in specific conditions. The test results should be presented as a power spectral density (PSD) plot with frequencies on the horizontal axis and amplitude on the vertical axis. The helicopter data and FSTD data should be presented in the same format with the same scaling. The algorithms used for generating the FSTD data should be the same as those used for the helicopter data. If they are not the same, then the algorithms used for the FSTD data should be proven to be sufficiently comparable. As a minimum the results along the dominant axes should be presented and a rationale for not presenting the other axes should be provided.

3.4.2 Interpretation of results. The overall trend of the PSD plot should be considered while focusing on the dominant frequencies. Less emphasis should be placed on the differences at the high frequency and low amplitude portions of the PSD plot. During the analysis it should be considered that certain structural components of the FSTD have resonant frequencies that are filtered and thus may not appear in the PSD plot. If such filtering is required, the notch filter bandwidth should be limited to 1 Hz to ensure that the buffet feel is not adversely affected. In addition, a rationale should be provided to explain that the characteristic motion vibration is not being adversely affected by the filtering. The amplitude should match helicopter data as per the description below. However, if for subjective reasons the PSD plot was altered, a rationale should be provided to justify the change. If the plot is on a logarithmic scale, it may be difficult to interpret the amplitude of the buffet in terms of acceleration. A 1x10-3 grms2/Hz would describe a heavy buffet. On the other hand, a 1x10-6 grms2/Hz buffet is almost not perceivable, but may represent a buffet at low speed. The previous two examples could differ in magnitude by 1 000. On a PSD plot this represents three decades (one decade is a change in order of magnitude of 10; two decades is a change in order of magnitude of 100, etc.).

4. Visual system

4.1 Visual display system

4.1.1 Contrast ratio (daylight systems). This should be demonstrated using a raster drawn test pattern filling the entire visual scene (three or more channels) consisting of a matrix of black and white squares no larger than 5 degrees per square with a white square in the centre of each channel. Measurement should be made on the centre bright square for each channel using a 1 degree spot photometer. Measure any adjacent dark squares. The contrast ratio is the bright square value divided by the dark square value. Lightpoint contrast ratio is measured when lightpoint modulation is just discernable compared to the adjacent background. See paragraph 5.b(3) and paragraph 5.b(7) of the table of Simulator validation tests.

4.1.2 Highlight brightness test (daylight systems). This should be demonstrated by maintaining the full test pattern described above, the superimposing a highlight on the centre white square of each channel and measure the brightness using the 1 degree spot photometer. Lightpoints are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable. See paragraph 5.b(4) of the table of Simulator validation tests .

4.1.3 Resolution (daylight systems) should be demonstrated by a test of objects shown to occupy a visual angle of not greater than the specified value in arc minutes in the visual scene from the pilot's eye point. This should be confirmed by calculations in the statement of compliance. See paragraph 5.b(5) of the table of Simulator validation tests.

4.1.4 Lightpoint size (daylight systems) should be measured in a test pattern consisting of a single row of lightpoints reduced in length until modulation is just discernible. See paragraph 5.b(7) of the table of Simulator validation tests.

4.1.5 Lightpoint size (twilight and night systems) – of sufficient resolution so as to enable achievement of visual feature recognition tests according to paragraph 5.b(7) of the table of Simulator validation tests.

4.1.6 Field of view (FOV). A continuous field of view is a fundamental requirement. Any visual display solution would be considered as long as it fulfils this requirement. Deviations from the minimum required field of view would only be considered when associated with helicopter structural cockpit masking. Although the visual system has to meet the test requirements at the pilot's design eye reference point, the visual system should cater for nominal pilot(s) head movement in support of the training.

4.2 Visual ground segment

4.2.1 Altitude and RVR for the assessment have been selected in order to produce a visual scene that can be readily assessed for accuracy (RVR calibration) and where spatial accuracy (centreline and G/S) of the simulated helicopter can be readily determined using approach/runway lighting and cockpit instruments.

4.2.2 The QTG should indicate the source of data, i.e. aerodrome and runway used, ILS G/S antenna location (airport and helicopter), pilot eye reference point, cockpit cut-off angle, helicopter pitch angle etc., used to make accurate visual ground segment (VGS) scene content calculations.

4.2.3 Automatic positioning of the simulated helicopter on the ILS is encouraged. If such positioning is accomplished, diligent care should be taken to ensure the correct spatial position and helicopter attitude is achieved. Flying the approach manually or with an installed autopilot should also produce acceptable results.

5. Sound system

5.1 General

5.1.1 The total sound environment in the helicopter is very complex, and changes with atmospheric conditions, helicopter configuration, airspeed, altitude, power settings, etc. Thus, cockpit sounds are an important component of the cockpit operational environment and as such provide valuable information to the flight crew. These aural cues can either assist the crew, as an indication of an abnormal situation, or hinder the crew, as a distraction or nuisance. For effective training, the FSTD should provide cockpit sounds that are perceptible to the pilot during normal and abnormal operations, and that are comparable to those of the helicopter. Accordingly, the FSTD operator should carefully evaluate background noises in the location being considered. To demonstrate compliance with the sound requirements, the objective or validation tests in this paragraph have been selected to provide a representative sample of normal static conditions typical of those experienced by a pilot.

5.2 Alternate engine fits

5.2.1 For FSTDs with multiple engine configurations any condition listed in the table of FSTD validation tests that is identified by the helicopter manufacturer as significantly different due to a change in engine model, should be presented for evaluation as part of the QTG.

5.3 Data and data collection system

5.3.1 Information provided to the FSTD manufacturer should contain calibration and frequency response data.

5.3.2 The system used to perform the tests listed in the table of FSTD validation tests, should comply with the following standards:

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

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

5.4 Headsets

5.4.1 If headsets are used during normal operation of the helicopter, they should also be used during the FSTD evaluation.

5.5 Playback equipment.

5.5.1 Recordings of the QTG conditions according to the table of FSTD validation tests should be provided during initial evaluations.

5.6 Background noise

5.6.1 Background noise is the noise in the FSTD, due to the FSTD's cooling and hydraulic systems, that is not associated with the helicopter, and the extraneous noise from other locations in the building. Background noise can seriously impact the correct simulation of helicopter sounds, so the goal should be to keep the background noise below the helicopter sounds. In some cases, the sound level of the simulation can be increased to compensate for the background noise. However, this approach is limited by the specified tolerances and by the subjective acceptability of the sound environment to the evaluation pilot.

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

(a) 70 dB @ 50 Hz;

(b) 55 dB @ 1 000 Hz;

(c) 30 dB @ 16 kHz.

5.6.3 These limits are for unweighted 1/3 octave band sound levels. Meeting these limits for background noise does not ensure an acceptable FSTD. Helicopter sounds that fall below this limit require careful review and may require lower limits on the background noise.

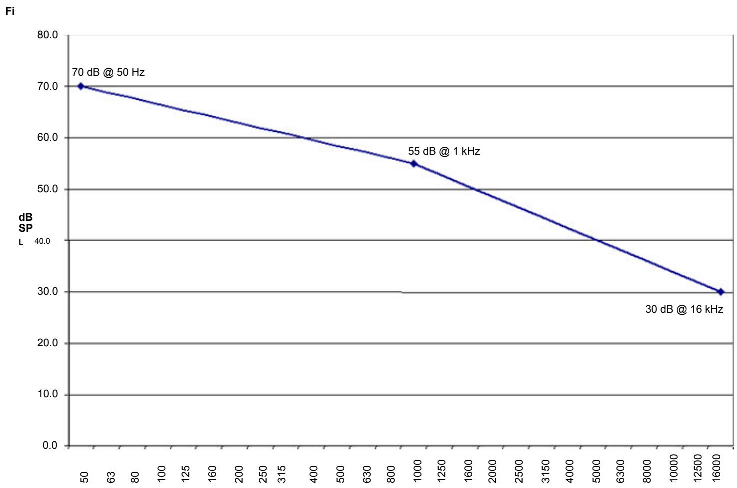

Figure 3. 1/3 Octave Band Frequency (Hz)

5.6.4 The background noise measurement may be rerun at the recurrent. The tolerances to be applied are that recurrent 1/3 octave band amplitudes cannot exceed 3 dB when compared to the initial results.

5.7 Frequency response

5.7.1 Frequency response plots for each channel should be provided at initial evaluation. These plots may be rerun at the recurrent evaluation. The tolerances to be applied are as follows:

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

(b) the average of the sum of the absolute differences between initial and recurrent results cannot exceed 2 dB (refer to table 1 below).

5.8 Initial and recurrent evaluations.

5.8.1 If recurrent frequency response and FSTD background noise results are within tolerance, respective to initial evaluation results, and the operator can prove that no software or hardware changes have occurred that will affect the helicopter cases, then it is not required to rerun those cases during recurrent evaluations.

5.9 If helicopter cases are rerun during recurrent evaluations, then the results may be compared against initial evaluation results rather than helicopter master data.

5.10 Validation testing.

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

(a) variation of data between tail numbers;

(b) frequency response of microphones;

(c) repeatability of the measurements; and

(d) extraneous sounds during recordings.

Band Centre Freq.	**Initial Results (dBSPL)**	**Recurrent Results (dBSPL)**	**Absolute Difference**	**Band Centre Freq.**	**Initial Results (dBSPL)**	**Recurrent Results (dBSPL)**	**Absolute Difference**
50	75	73.8	1.2	1000	79.2	80.1	0.9
63	75.9	75.6	0.3	1250	80.7	82.8	2.1
80	77.1	76.5	0.6	1600	81.6	78.6	3
100	78	78.3	0.3	2000	76.2	74.4	1.8
125	81.9	81.3	0.6	2500	79.5	80.7	1.2
160	79.8	80.1	0.3	3150	80.1	77.1	3
200	83.1	84.9	1.8	4000	78.9	78.6	0.3
250	78.6	78.9	0.3	5000	80.1	77.1	3
315	79.5	78.3	1.2	6300	80.7	80.4	0.3
400	80.1	79.5	0.6	8000	84.3	85.5	1.2
500	80.7	79.8	0.9	10000	81.3	79.8	1.5
630	81.9	80.4	1.5	12500	80.7	80.1	0.6
800	73.2	74.1	0.9	16000	71.1	71.1	0
						Average	**1.1**

Table 1 - Example of recurrent frequency response test tolerance

CHAPTER 6 FUNCTIONS AND SUBJECTIVE TESTS

1. Discussion

1.1 Accurate replication of helicopter systems functions will be checked at each flight crewmember position. This includes procedures using the operator's approved manuals, aircraft manufacturer's approved manuals and checklists. Handling qualities, performance, and simulator systems operation will be subjectively assessed. In order to assure that functions tests are conducted in an efficient and timely manner, operators are encouraged to coordinate with the CAD so that any skills, experience or expertise needed by the CAD in charge of the evaluation team are available.

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 aircraft. Unlike the objective tests listed in Chapter 5, the subjective testing should cover those areas of the flight envelope which may reasonably be reached by a trainee, even though the simulator has not been approved for training in that area. Thus it is prudent to examine, for example, the normal and abnormal simulator performance to ensure that the simulation is representative even though it may not be a requirement for the level of approval being sought. (Any such subjective assessment of the simulation should include reference to Chapters 4 and 5 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.)

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

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.

2. Test Requirements

2.1 The ground and flight tests and other checks required for qualification are listed in the Table of Functions and Subjective Tests (Appendix 1). The table includes manoeuvres and procedures to assure that the 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.

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

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.

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 helicopter. However, for the lower levels of qualification the degree of fidelity may be reduced in accordance with the criteria contained in Chapters 4 and 5.

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.

2.6 Evaluation of the lower orders of FSTDs should be tailored only to the systems and flight conditions which have been simulated. Similarly, many tests should be applicable for automatic flight. Where automatic flight is not possible and pilot manual handling is required, the FSTD should be at least controllable to permit the conduct of the flight.

CHAPTER 6 APPENDIX 1

FUNCTIONS AND SUBJECTIVE TESTS

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS		FFS				FTD			FNPT			
		A	B	C	D	1	2	3	I	II	III	MCC
a	**PREPARATION FOR FLIGHT**											
	Preflight: accomplish a functions check of all switches, indicators, systems and equipment at crew members and instructors stations and determine that the cockpit design and functions are identical to that of the helicopter within the scope of simulation.	✓	✓	✓	✓	✓	✓	✓				
	Preflight: accomplish a functions check of all switches, indicators, systems, and equipment at all crew members' and instructor's stations and determine that the cockpit design andfunctions represents those of a helicopter.								✓	✓	✓	✓
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) Rotor start/engagement and acceleration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(b) Ground resonance (if applicable on type)	✓	✓	✓	✓							
	(3) Ground taxi (wheeled aircraft only)											
	(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) Lift-off	*	✓	✓	✓							
	(2) Hover	*	✓	✓	✓		✓	✓		✓	✓	✓
	(3) Instrument response											
	(a) Engine instruments	*	✓	✓	✓		✓	✓		✓	✓	✓
	(b) Flight instruments	*	✓	✓	✓		✓	✓		✓	✓	✓
	(4) Hovering turns	*	*	✓	✓		✓	✓		✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS		FFS				FTD			FNPT			
		A	B	C	D	1	2	3	I	II	III	MCC
	(5) Hover power checks											
	(a) In ground effect (IGE)	*	✓	✓	✓		✓	✓		✓	✓	✓
	(b) Out of ground effect (OGE)	*	✓	✓	✓		✓	✓		✓	✓	✓
	(6) Anti-torque effect	*		✓	✓		✓	✓		✓	✓	✓
	(7) 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	*	✓	✓	✓		✓	✓		✓	✓	✓
	(8) Crosswind/tailwind hover	*	✓	✓	✓		✓	✓		✓	✓	✓
d	**AIR TAXI/TRANSIT**											
	(1) Forward	*	✓	✓	✓		✓	✓		✓	✓	✓
	(2) Sideways	*	✓	✓	✓		✓	✓		✓	✓	✓
	(3) Rearward	*	✓	✓	✓		✓	✓		✓	✓	✓
e	**TAKE-OFF**											
	(1) Cat. B or single engine helicopters											
	(a) Normal											
	(i) From hover	*	✓	✓	✓		✓	✓		✓	✓	✓
	(ii) Crosswind/tailwind	*	✓	✓	✓		✓	✓		✓	✓	✓
	(iii) MTOM	*	✓	✓	✓		✓	✓		✓	✓	✓
	(iv) Confined area	*	✓	✓	✓			✓			✓	✓
	(v) Slope	*	✓	✓	✓			✓			✓	✓
	(vi) Elevated FATO/helideck	*	✓	✓	✓			✓			✓	✓
	(vii) Vertical	*	✓	✓	✓							
	(b) Abnormal/emergency procedures:											
	(i) Engine failure during take-off (if single engine, up to initiation of the flare)	*	✓	✓	✓		✓1	✓		✓1	✓	✓
	(ii) Forced landing (if single engine, up to initiation of the flare)	*	✓	✓	✓		✓	✓		✓1	✓	✓
	(2) Cat A operation for all certified profiles	*	✓	✓	✓		✓1	✓		✓1	✓	✓
	(a) Take-off with engine failure:											
	(i) Engine failure prior to TDP	*	✓	✓	✓		✓1	✓			✓	✓
	(ii) Engine failure at or after TDP	✓	✓	✓	✓		✓1	✓		✓1	✓	✓1

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS		**FFS**				**FTD**			**FNPT**			
		A	**B**	**C**	**D**	**1**	**2**	**3**	**I**	**II**	**III**	**MCC**
f	**CLIMB**											
	(1) Cat. B or single engine helicopters:											
	(a) Clear area	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(b) Obstacle clearance	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(c) Vertical	*	✓	✓	✓		✓	✓		✓	✓	✓
	(d) Engine failure	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(e) Other	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(2) Cat. A operation for all certified profiles											
	(a) with engine failure up to 300 m (1 000 ft) above the level of the aerodrome/operating site	✓	✓	✓	✓		✓	✓		✓	✓	✓
g	**CRUISE**											
	(1) Performance characteristics	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(2) Flying qualities (including turns at rate 1 and 2)	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(3) Turns:											
	(a) Turns at rate 1 and 2	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
	(b) Steep turns	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
	(4) Acceleration and decelerations	✓	✓	✓	✓							
	(5) High airspeed vibration cues	✓	✓	✓	✓							
	(6) Abnormal/emergency procedures:											
	(a) Engine fire	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(b) Engine failure	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(c) In flight engine shutdown and restart	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(d) Fuel governing system failures	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(e) Hydraulic failure	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(f) Stability system failure	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(g) Directional control malfunction	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(h) Rotor vibration cues	✓	✓	✓	✓							
	(i) Other	✓	✓	✓	✓		✓	✓		✓	✓	✓
h	**DESCENT**											
	(1) Normal	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(2) Maximum rate	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
	(3) Autorotative (until flare initiation):											
	(a) Straight in	*	✓	✓	✓		✓	✓	✓	✓	✓	✓
	(b) With turn	*	✓	✓	✓		✓	✓	✓	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS		FFS				FTD			FNPT			
		A	**B**	**C**	**D**	**1**	**2**	**3**	**I**	**II**	**III**	**MCC**
i	**VISUAL APPROACHES**											
	(1) Cat. B or single engine helicopters:											
	(a) Approach											
	(i) Normal	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(ii) Steep	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(iii) Shallow	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(iv) Vertical	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(b) Abnormal and 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 300 m (1 000 ft) above the level of the aerodrome/operating site to or after LDP	✓	✓	✓	✓		✓	✓		✓	✓	✓
j	**INSTRUMENT APPROACHES**											
	Only those instrument approach tests relevant to the simulated helicopter type or system(s) and MCC training should be selected from the following list.											
	(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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS		FFS				FTD			FNPT			
		A	B	C	D	1	2	3	I	II	III	MCC
	(d) Missed approach:											
	(i) All engines operating	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(ii) One or more engines inoperative	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(iii) Auto-pilot failure	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(2) Precision:											
	(a) All engines operating	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(b) One or more engines inoperative	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(c) Approach procedures:	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(i) DGPS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(ii) ILS: - Manual without flight director, - Manual with flight director - Autopilot coupled - CAT I - CAT II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(iii) Other	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(d) Missed approach:											
	(i) All engines operating	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(ii) One or more engines inoperative	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(iii) Auto pilot failure	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
k	**APPROACH TO LANDING AND TOUCH DOWN**											
	(1) Cat. B or single engine helicopters											
	(a) Normal approach											
	(i) To a hover	*	✓	✓	✓		✓1	✓		✓1	✓	✓
	(ii) Elevated FATO/helideck		✓	✓	✓			✓			✓	✓
	(iii) Confined area	*	✓	✓	✓			✓			✓	
	(iv) Crosswind/tailwind	*	✓	✓	✓		✓1	✓		✓1	✓	✓
	(v) Other	*	✓	✓	✓		✓1	✓		✓1	✓	✓
	(b) Touch down:											
	(i) From a hover	*	✓	✓	✓		✓1	✓		✓1	✓	✓
	(ii) Running	*	✓	✓	✓		✓1	✓		✓1	✓	✓
	(iii) Slope	*	*	✓	✓			✓			✓	

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS		**FFS**				**FTD**			**FNPT**			
		A	**B**	**C**	**D**	**1**	**2**	**3**	**I**	**II**	**III**	**MCC**
	(c) Abnormal and emergency procedures during approach to landing and touch down:											
	(i) OEI	✓	✓	✓	✓		✓1	✓		✓1	✓	✓
	(ii) Fuel governing failure	✓	✓	✓	✓		✓1	✓		✓1	✓	✓
	(iii) Hydraulics failure	✓	✓	✓	✓		✓1	✓		✓1	✓	✓
	(iv) Stability system failure	✓	✓	✓	✓		✓1	✓		✓1	✓	✓
	(v) Directional control failure	✓	✓	✓	✓		✓1	✓		✓1	✓	✓
	(vi) Autorotation	*	✓	✓	✓		✓1	✓		✓1	✓	✓
	(vii) Other	✓	✓	✓	✓		✓1	✓		✓1	✓	✓
	(2) Cat. A operation for all certified profiles											
	(a) Landing with engine failure:											
	(i) Engine failure prior to or at LDP	*	✓	✓	✓		✓1	✓		✓1	✓	✓
	(ii) Engine failure at or after LDP	*	✓	✓	✓		✓1	✓		✓1	✓	✓
I.	**ANY FLIGHT PHASE**											
	(1) Helicopter and powerplant systems operation (as applicable)											
	(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) Stabiliser	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(i) Flight controls/antitorque systems	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(j) Fuel and oil	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(k) Hydraulic	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(l) Landing gear	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(m) Power plant	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(n) Transmission systems	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(o) Rotor systems	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(p) Flight control computers	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(q) Stability and control augmentation systems (SAS)	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(r) Voice activated systems	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(s) Other	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS		FFS				FTD			FNPT			
		A	B	C	D	1	2	3	I	II	III	MCC
	(2) Flight management and guidance systems (as applicable)											
	(a) Airborne radar	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(b) Automatic landing aids	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(c) Autopilot	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(d) Collision avoidance systems (GPWS, ACAS,.)	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(e) Flight data displays	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(f) Flight management computers	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(g) Head-up displays	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(h) Navigation system	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(i) NVG	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(j) Other	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(3) Airborne procedures											
	(a) Quickstop	*	*	✓	✓		✓	✓		✓	✓	✓
	(b) Holding pattern	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
	(c) Hazard avoidance (GPWS, TCAS, Weather radar). As applicable, except for weather radar required for MCC training in FNPT.	*	*	✓	✓		✓	✓		✓	✓	✓
	(d) Retreating blade stall recovery (as applicable)	*	✓	✓	✓		✓	✓		✓	✓	✓
	(e) Rotor mast bumping (as applicable)	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(f) Vortex ring	*	✓	✓	✓		✓	✓		✓	✓	✓
m	**ENGINE SHUTDOWN AND PARKING**											
	(1) Engine and systems operation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(2) Parking brake operation	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(3) Rotor brake operation	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(4) Abnormal and emergency procedures	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	(5) Other	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
n	**MOTION EFFECTS**											
	(1) Runway rumble, oleo deflections, effects of ground speed 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 touch down	*	✓	✓	✓							
	(7) Rotor(s) vibrations (motion cues)	✓	✓	✓	✓							

	TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	**FFS**				**FTD**			**FNPT**			
		A	**B**	**C**	**D**	**1**	**2**	**3**	**I**	**II**	**III**	**MCC**
	(8) Translational lift	*	✓	✓	✓							
	(9) Loss of anti-torque device effectiveness	*	✓	✓	✓							
o	**SOUND SYSTEM**											
	Significant helicopter noises should include:											
	(1) Engine, rotor and transmission to a comparable level found in the helicopter.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	(2) Sounds of a crash should be related to a logical manner to landing in an unusual attitude or in excess of structural limitations of the helicopter.	✓	✓	✓	✓		✓	✓	✓	✓	✓	
	(3) Significant cockpit sounds and those which result from pilot's actions.	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
p	**SPECIAL EFFECTS**											
	(1) Effects of icing:											
	(a) Airframe	*	*	✓	✓		✓2	✓2		✓2	✓2	✓2
	(b) Rotors	*	*	✓	✓		✓2	✓2		✓2	✓2	✓2
	(2) Effects of rotor contamination.			✓	✓							
q	**VISUAL SYSTEM**											
	(1) Accurate portrayal of environment relating to simulator attitudes and position.	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(2) Aerodromes/operating sites:											
	(a) The distances at which aerodrome/operating site 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) Aerodrome definition, strobe lights, approach lights from 8 km	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(ii) Visual approach aids and FATO/LOF edge lights should be visible from 5kmthrough approach angles up to 12 degrees	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(iii) FATO/LOF 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 surface resolution on day scenes	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(b) At least three different aerodrome/operating site scenes which should be:											
	(i) an airport	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(ii) a surface level confined area and		✓	✓	✓			✓			✓	✓
	(iii) an elevated FATO		✓	✓	✓			✓			✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS		FFS				FTD			FNPT			
		A	B	C	D	1	2	3	I	II	III	MCC
	(c) Representative aerodrome/operating site scene content including the following:											
	(i) Surfaces and markings on runways, operating sites, taxiways and ramps	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(ii) Lighting for the FATO/TLOF, visual approach aids and approach lighting of appropriate colours	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(iii) Aerodrome/operating site perimeter and taxiway lighting	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(iv) Ramps and terminal buildings and vertical objects which correspond to the operational requirements of an operator's LOFT scenario.	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(v) The directionality of strobe lights, approach lights, runway edge lights, visual landing aids, runway centre line lights, threshold lights, and touch down zone lights on the runway of intended landing should be realistically replicated	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(3) Representative visual effect of helicopter external lighting in reduced visibility, such as reflected glare, to include landing lights, strobes, and beacons		✓	✓	✓		✓	✓		✓	✓	✓
	(4) Instructor controls of the following:											
	(a) Cloud base/cloud tops;	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(b) Visibility in kilometres or nautical miles and RVR in meters or feet;	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(c) Aerodrome/operating site selection;	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(d) Aerodrome/operating site lighting;	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(e) Ground and flight traffic.			✓	✓		✓	✓				✓
	(5) Visual system compatibility with aerodynamic programming	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(6) Visual cues to assess sink rate displacements, rates and height AGL during landings (e.g. runways/operating sites, taxiways, ramps and terrain features).	*	✓	✓	✓		✓	✓		✓	✓	✓
	(7) Visual scene capability:											
	(a) Twilight and night	✓	✓									
	(b) Twilight, night and day			✓	✓		✓	✓		✓	✓	✓
	(8) General terrain characteristics Below 5 000 ft present realistic visual scene permitting navigation by sole reference to visual landmarks. Terrain contouring should be suitably represented.	*	✓	✓	✓		✓	✓			✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	**FFS**				**FTD**			**FNPT**			
	A	**B**	**C**	**D**	**1**	**2**	**3**	**I**	**II**	**III**	**MCC**
(9) At and below 610 m (2 000 ft) height above the aerodrome/operating site and within a radius of 16 km (9 NM) from the aerodrome/operating site, 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) Visibility and RVR measured in terms of distance	✓	✓	✓	✓		✓	✓		✓	✓	✓
(f) Patchy fog			✓	✓							
(g) The effect of fog on aerodrome/operating site lighting.			✓	✓		✓	✓			✓	✓
(10) A capability to present ground and air hazards such as another aircraft crossing the active runway and converging airborne traffic			✓	✓							✓
(11) Operational visual scenes which provide a cue rich environment sufficient for precise low airspeed and low altitude manoeuvring and landing.			✓	✓		✓	✓			✓	✓
(12) 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. *Note - illusions may be demonstrated at a generic aerodrome or specific aerodrome/ operating site.*				✓							
(13) Special weather representations of light, medium, heavy precipitation and lighting near a thunderstorm on take-off, approach and landing at and below an altitude of 610 m (2 000 ft) above the aerodrome/operating site surface and within a radius of 16 km (9 NM) from the aerodrome/operating site.				✓							
(14) Wet and snow-covered landing areas including runway/operating site lighting reflections for wet, partially obscured lights for snow or suitable alternative effects.				✓							
(15) The effects of swell and wind on a 3-dimensional ocean model should be simulated.				✓							
(16) 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.				✓							
(17) Realistic colour and directionality of aerodrome/operating site lighting.	✓	✓	✓	✓		✓	✓		✓	✓	✓
(18) The visual scene should correlate with integrated helicopter systems, where fitted (e.g. terrain, traffic and weather avoidance systems and head-up guidance system (HUGS)) (For FTD and FNPT may be restricted to specific geographical areas.) Weather radar presentations in helicopters where radar information is presented on the pilot's navigation instruments. Radar returns should correlate to the visual scene.			✓	✓		✓	✓				✓
(19) 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.			✓	✓							

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS		FFS				FTD			FNPT			
		A	B	C	D	1	2	3	I	II	III	MCC
	(20) To support LOFT, the visual system should provide smooth transition to new operational scenes without flight through clouds.				✓			✓			✓	✓
	(21) The visual system should provide appropriate height and 3-D object collision detection feedback to support training.			✓	✓		✓	✓		✓	✓	✓
	(22) Scene quality											
	(a) surfaces and textural cues should be free from distracting quantisation (aliasing)	✓	✓	✓	✓		✓	✓		✓	✓	✓
	(b) the system lightpoints should be free from distracting jitter, smearing or streaking			✓	✓							
	(c) system capable of six discrete light step controls (0 -5)	✓	✓	✓	✓		✓	✓		✓	✓	✓

Notes

General: Motion and buffet cues should only be applicable to FSTD equipped with an appropriate motion system

(1) Limited to clear area profiles

(2) Limited to performance

** Check for the absence of negative effect*

CHAPTER 7 LEVEL 'A' FLIGHT SIMULATORS

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 CAD 453(H) recognizes the criteria for Level 'A' Simulators, the requirements 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 aircraft used by the general aviation community.

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

1.3.1 type-specific data package;

1.3.2 QTG flight test data;

1.3.3 motion system;

1.3.4 visual system;

1.3.5 flight controls; and

1.3.6 aircraft parts.

NOTE: To attempt to reduce the cost of ownership of a CAD Level-A FFS, each element has been examined in turn and with a view to relaxing the requirements where possible whilst recognizing the training, checking and testing credits allowed on such a device.

2. Data package

2.1 The cost of collecting specific flight test data sufficient to provide a complete model of the aerodynamics, engines and flight controls can be significant. The use of a class specific data package which could be tailored to represent a specific type of helicopter is encouraged. This may enable a well-engineered light-twin baseline data package to be carefully tuned to adequately represent any one of a range of similar helicopters. Such work including justification and the rationale for the changes would have to be carefully documented and available for consideration by the Department as part of the qualification process. Note that for this lower level of FFS, 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. Recognizing the cost of gathering such data, the following points should be borne in mind:

2.2.1 For this class of 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.

2.2.2 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.

2.2.3 The use of CT&M is not to be taken as an indication that certain areas of simulation can be ignored. Indeed in the class of 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 FFS to exhibit neutral or negative spiral stability).

2.2.4 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 FFS, 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 FFS, the FFS 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 never provides 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 never provide negative training.

4. Visual

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

4.2 The collimated visual optics may not always be needed. A single channel direct viewing system would be acceptable for an FFS of a single crew helicopter.

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

4.3.1 at the CAT I All Weather Operations decision height, the appropriate visual ground segment may not be seen; and

4.3.2 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

5.1 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 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

6.1 As with any level of FSTD, the components used within the cockpit area need not be aircraft parts; however, any parts used should be robust enough to ensure the training tasks. Moreover, the Level A FFS is type specific, thus all relevant switches, instruments, controls etc. within the simulated area will be required to look and feel 'as helicopter'.

CHAPTER 8 FLIGHT SIMULATORS APPROVED OR QUALIFIED UNDER PREVIOUS REGULATIONS

1. Introduction

1.1 Under previous regulations, 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 the Department giving broad or specific permission for them to be used for certain training, testing and checking maneuvers.

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 publication of CAD 453(H).

2. Re-categorisation

2.1 Some of these flight simulators may be of a standard which permits them to be re-categorised as if they were simulators presented for initial qualification under CAD 453(H).

3. Equivalent categories AG, BG, CG, DG

3.1 Flight simulators that are not re-categorised but which have an acceptable primary reference document used for their original qualification or approval, will gain a CAD qualification based upon their original technical qualification level or credits which are equivalent to those described in this Document. The equivalent qualification will relate to permitted maneuvers in the original Qualification/Approval document providing that these older flight simulators continue to meet the original criteria when evaluated by the Department.

3.2 The following table describes the relationship:

CAD QUALIFICATION LEVEL Flight Simulators Qualified Under Previous Regulations	CAD QUALIFICATION LEVEL Flight Simulators Qualified Under CAD 453(H)
AG Similar maximum credits for A	
BG Similar maximum credits for B	
CG Similar maximum credits for C	
DG 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 simulator and in particular the maneuvers for which the equivalent CAD qualification level is given. The minimum acceptable standard is JAR-STD 1A Issued 30 April 1997, FAA AC 120-40B, ICAO 9625 First Edition, International Standards For The Qualification of Airplane Flight Simulators (January 1992) or equivalent.

4. Original qualification

4.1 Flight Simulators that are not re-categorised and that do not have an acceptable primary reference document may continue to enjoy credits for an agreed list of training, testing and checking maneuvers, provided they maintain their performance in accordance with any validation, Functions and Subjective Tests which have been previously established or a list of tests selected from CAD 453(H) by agreement with the Department. Again the test should relate to the list of maneuvers permitted under the original Qualification/Approval document.

4.2 The award of credits to a flight simulator user should be at the discretion of the Department. Current users may retain the credits granted under their previous criteria.

5. Grandfather rights summary

5.1 The following Table summarizes the arrangements for simulators approved or qualified under previous regulations and which are not re-categorised:

	CAD EQUIVALENT QUALIFICATION LEVEL	PERFORMANCE CRITERIA
Primary Reference Document	AG Maximum training, testing BG and checking Credits CG similar to A, B, C, D DG	Performance to the original National Validation Functions and Subjective Tests from Reference Doc.
No Primary Reference Document	<u>Special Categories</u> Unique list of Maneuvers	Original Validation, Functions and Subjective Tests or a list of tests selected from CAD 453(H).

CHAPTER 9 NEW AIRCRAFT PROGRAMMES

1. New helicopter simulator qualification

1.1 During the introduction of new helicopter programs, it is not always possible to obtain all the necessary data and certified helicopter avionics in time to satisfy the requirements for normal simulator qualification. The Department 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.

1.2 Simulator operators seeking interim qualification should contact the Department at the earliest opportunity.

2. New helicopter simulator qualification – additional information

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

2.2 In recognition of the sequence of events that should occur and the time required for final data to become available, the Department 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.

2.3 Operators seeking qualification based on preliminary data should, however, consult the Department 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 simulator qualification. The helicopter and simulator manufacturers should also be made aware of the requirements and agree to the data plan and simulator qualification plan. The plan should include periodic meetings to keep the interested parties informed of project status.

2.4 The precise procedure followed to gain Department 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 operator, the helicopter manufacturer, the simulator manufacturer, and the Department.

NOTE: A description of helicopter manufacturer provided data needed for simulator modelling and validation is to be found in the IATA Document 'Flight Simulator Design and Performance Data Requirements' edition 6 2000 or as amended), or in the ARINC Specification 450 Document 'Flight Simulator Design and Performance Data Requirements' published on December 2, 2016 or as amended .

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

2.5.1 a manufacturer's engineering report explaining the predictive method used and illustrating past success of the method on similar projects. For example, the manufacturer could show the application of the method to an earlier helicopter model or predict the characteristics of an earlier model and compare the results to final data for that model; and

2.5.2 early flight test data will often be derived from helicopter certification tests, and should be used to maximum advantage for early 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 an 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. It is expected that the flight test programme of the helicopter manufacturer will include provisions for generation of very early flight tests results for simulator validation.

2.6 The use of preliminary data is not indefinite. The helicopter manufacturer's final data should be available within six months after helicopter first 'service entry' or as agreed by the Department, the operator and the helicopter manufacturer, but usually not later than one year. In applying for an interim qualification, using preliminary data, the Operator and the Department should agree the update programme. This will normally specify that the final data update will be installed in the simulator within a period of six months following the final data release unless special conditions exist and a different schedule agreed. The 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 simulator programming and validation

2.7 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 checking are affected. Permitted differences in helicopter and simulator avionics versions and the resulting effects on simulator qualification should be agreed between the operator and the Department. Consultation with the flight simulator manufacturer is desirable throughout the agreement of the qualification process.

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

2.8.1 the plan should consist of the development of a QTG based upon a mix of flight test and engineering simulation data. For data collected from specific 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; and

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

(a) Propulsion

(b) Aerodynamics

(c) Mass Properties

(d) Flight Controls

(e) Stability Augmentation

(f) Brakes/Landing Gear

2.9 For the qualification of flight simulators of new helicopters 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 (POM) should meet the relevant CAD 453(H) tolerances as detailed in Chapter 5, Appendix 1.

CHAPTER 10 QUALITY SYSTEM

1. Introduction

1.1 In order to demonstrate compliance with Chapter 2, paragraph 3.1, an operator of a flight simulator should establish its quality system in accordance with the instruction and information contained in the following paragraphs.

2. General

2.1 Terminology

2.1.1 The terms used in the context of the requirement for an AOC.s quality system have the following meaning:

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

(b) *Quality Assurance*. Quality assurance, as distinguished from quality control, involves activities in the business, systems, and technical audit areas. It is a set of predetermined, systemic actions which are required to provide adequate confidence that the performance, functions and characteristics satisfy given requirements.

2.2 Quality control

2.2.1 An operator shall 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 CAD 453(H) together with any additional standards specified by the operator.

2.2.2 The Accountable Manager is an essential part of the operator's management organisation. It is usually the Chief Executive Officer, or equivalent, of the operator, 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 operator's quality system, including the frequency, format and structure of the internal management evaluation activities as prescribed in paragraph 4.10 below.

2.3 Purpose of the Quality System

2.3.1 The quality system should enable the operator to monitor compliance with CAD 453(H), and any other standards specified by the operator, or the CAD, to ensure performance of the device.

2.4 Quality Manager

2.4.1 The function of the Quality Manager to monitor compliance with, and the adequacy of, procedures required to ensure performance of the device as required by the regulations and requirements may be carried out by more than one person by means of different, but complementary, quality assurance programs.

2.4.2 The primary role of the Quality Manager is to verify, by monitoring activity in the fields of simulator operation, that the standards required by the CAD, and any additional requirements defined by the operator, are being carried out under the supervision of the manager.

2.4.3 The Quality Manager should be responsible for ensuring that the quality assurance programme is properly established, implemented and maintained.

2.4.4 The Quality Manager should:

(a) report to the Accountable Manager; and

(b) have access to all parts of the simulator operator's, and as necessary, any sub-contractor's organisation.

2.4.5 The posts of Accountable Manager and the Quality Manager may be combined by simulator 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 structure

3.1 Introduction

3.1.1 The operator's quality system should ensure compliance with simulator qualification requirements, standards, and operational procedures.

3.1.2 The operator should specify the basic structure of the quality system.

3.1.3 The quality system should be structured according to the size and complexity of the operation to be monitored.

3.2 Scope

3.2.1 As a minimum, the quality system should address the following:

(a) the provisions of CAD 453(H);

(b) the operator's additional standards and operating practices;

(c) the operator's quality policy;

(d) the operator's organizational structure;

(e) responsibility for the development, establishment and management of the quality system;

(f) documentation, including manuals, reports and records;

(g) quality procedures;

(h) quality assurance programme;

(i) the provision of adequate financial, material and human resources; and

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 includes the relevant part of the operator's manual system.

3.3.2 In addition, relevant document should include the following:

(a) quality policy;

(b) terminology;

(c) reference to the specified simulator 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;

(h) schedule of the monitoring process;

(i) audit procedures;

(j) reporting procedures;

(k) follow-up and corrective action procedures;

(l) recording system;

(m) the training syllabus; and

(n) document control

4. Quality Assurance program

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 performance maintained in accordance with all applicable requirements, standards and operational procedures.

4.1.2 When establishing a quality assurance programme, consideration should be given to at least the following:

(a) quality inspection;

(b) audit;

(c) auditors;

(d) auditor's independence;

(e) audit scope;

(f) audit scheduling;

(g) monitoring and corrective action;

(h) management evaluation; and

(i) recording.

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 operational 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 simulator operations;

(b) maintenance;

(c) technical standards; and

(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 operation is being conducted against the way in which the published operational 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 that 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 that make up the operation; and

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

4.4 Auditors

4.4.1 An operator should decide, depending upon the complexity of the operations, whether to make use of a dedicated audit team or a single auditor. In any event, the auditor or audit team should have relevant simulator 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 the operation activity that is to be audited. An 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. An operator whose structure and size does not justify the establishment of full-time auditors, may undertake the audit function by the use of part-time personnel from within its own organisation or from an external source under the terms of an agreement acceptable to the CAD. In all cases the 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 devices operated by the simulator operator.

4.5.2 The 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 timescales; and

(e) report directly to the Quality Manager.

4.6 Audit scope

4.6.1 Operators are required to monitor compliance with the operational procedures they have designed to ensure safe operations and the serviceability of both operational and safety equipment. In doing so they should as a minimum, and where appropriate, monitor:

(a) organisation;

(b) plans and company objectives;

(c) maintenance procedures;

(d) simulator qualification level;

(e) supervision;

(f) simulator technical status;

(g) manuals, logs and records;

(h) defect deferral;

(i) personnel training; and

(j) helicopter modification management.

4.7 Audit Scheduling

4.7.1 A quality assurance programme should include a defined audit schedule and a periodic review cycle area by area. 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 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 12 month period 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 its discretion but should not decrease the frequency without the agreement of the CAD.

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

4.8 Monitoring

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, operational, and maintenance standards are continuously complied with. Monitoring activity is based upon quality inspections, audits, corrective action and follow-up. The 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.

4.9 Corrective action

4.9.1 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. Organizational responsibility and accountability for the implementation of corrective action resides with the department cited in the report identifying the finding. The Accountable Manager will have the ultimate responsibility for resourcing the corrective active action and ensuring, through the Quality Manager, that the corrective action has reestablished compliance with the standard required by the CAD, and any additional requirements defined by the operator.

4.9.2 Subsequent to the quality inspection/audit, the operator should establish:

(a) the seriousness of any findings and any need for immediate corrective action;
(b) the cause of the finding;

(c) what corrective actions are required to ensure that the non-compliance does not recur;

(d) a schedule for corrective action;

(e) the identification of individuals or departments responsible for implementing corrective action; and

(f) allocation of resources by the accountable manager, where appropriate.

4.9.3 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 the corrective action includes the elements outlined in paragraph 10.3.9 above;

(c) monitor the implementation and completion of corrective action;

(d) provide management with an independent assessment of corrective action; implementation and completion; and

(e) evaluate the effectiveness of corrective action through follow-up process.

4.10 Management Evaluation

4.10.1 A management evaluation is a comprehensive, systematic, documented review by the management of the quality system, operational policies and procedures, and should conside

(a) the results of quality inspections, audits and any other indicators; and

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

4.10.2 A management 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.

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

4.11 Recording

4.11.1 Accurate, complete and readily accessible records documenting the results of the quality assurance programme should be maintained by the operator. Records are essential data to enable an operator to analyze and determine the root causes of non-conformity, so that areas of non-compliance can be identified and addressed.

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

5.1.1 maintenance; and

5.1.2 manual preparation.

5.2 The ultimate responsibility for the product or service provided by the sub-contractor always remains with the operator. A written agreement should exist between the operator and the sub-contractor clearly defining the safety related services and quality to be provided. The sub-contractor's safety related activities relevant to the agreement should be included in the operator's quality assurance programme.

5.3 The operator should ensure that the sub-contractor has the necessary authorisation/approval when required and commands the resources and competence to undertake the task.

6. Quality system training

6.1 General

6.1.1 An 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) the 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 company.

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 organisations and International Standards Institutions, and an operator should consider whether to offer such courses to those likely to be involved in the management of quality systems. Operators with sufficient appropriately qualified staff should consider whether to carry out in-house training.

7. Standard measurements for flight simulator quality

7.1 It is recognised that a Quality System tied to measurement of simulator performance will probably lead to improving and maintaining training quality. One acceptable means of measuring simulator performance is as defined and agreed by industry in ARINC report 433 (April 5, 2013 or as amended) entitled “Standard Measurements for Flight Simulator Quality”.

APPENDUM

I. Suggested reference sources to be read in conjunction with CAD 453(H) are listed below:

(i) ICAO Doc 9625 – Manual of Criteria for the Qualification of Flight Simulation Training Devices

(ii) EASA Certification Specifications for Rotorcraft Flight Simlation Training Devices (CS-FSTD(H))

(iii) FAA Regulations 14 CFR Part 60 – Flight Simulation Training Device Initial and Continuing Qualification and Use

(iv) Transport Canada TP 9685 – Aeroplane and Rotorcraft Simulator Manual

(v) International Standards for the Qualification of Rotorcraft Flight Simulators.

Note: The above listed reference sources above are not to be considered as exclusive nor exhaustive. The latest versions/issues of these documents shall be consulted.

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