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SUBPART A - APPLICABILITY

YCAR-STD 2H.001 Applicability

YCAR-STD 2H applies to those persons, organisations or enterprises (STD operators) seeking qualification of Flight Training Devices (FTD). STD users also shall gain approval to use the FTD as part of their approved training programmes despite the fact that the FTD has been previously qualified. Although this document provides guidance for STD users, precise details of such approvals are contained in YCAR-OPS and other applicable documents.

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

SUBPART B - GENERAL

YCAR-STD 2H.005 Terminology
(See AC STD 2H.005)

Because of the technical complexity of STD qualification, it is essential that standard terminology is used throughout. The following principle terms and abbreviations shall be used in order to comply with YCAR-STD.

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

(b) *Flight Simulator (FS).* A full size replica of a specific type or make, model and series helicopter flight deck, 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 view, and a force cueing motion system. It is in compliance with the minimum standards for a specific FS Level of Qualification

(c) *Flight Training Device (FTD).* A full size replica of a specific helicopter type's instruments, equipment, panels and controls in an open flight deck area or an enclosed helicopter flight deck, including the assemblage of equipment and computer software programmes necessary to represent the helicopter in ground and flight conditions to the extent of the systems installed in the device. It is in compliance with the minimum standards for a specific FTD Level of Qualification.

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

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

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

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

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

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

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

SUBPART C - HELICOPTER FLIGHT TRAINING DEVICES

YCAR-STD 2H.015 Application for FTD Qualification

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

(a) The operator of an FTD requiring evaluation of this FTD shall apply to the Authority giving 3 months notice.

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

(c) Exceptionally, for the initial evaluation of an FTD, the period of notice may be reduced to one month at the discretion of the Authority.

YCAR-STD 2H.020 Validity of FTD Qualification

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

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

(c) The Authority may refuse, revoke, suspend or vary an FTD qualification, if the provisions of YCAR-STD 2H are not satisfied.

(d) The Authority may complete a special evaluation following major changes or when an FTD appears not to be performing at its initial Qualification Level.

YCAR-STD 2H.025 Rules governing STD Operators

(See AC YCAR-STD 2H.025)

The operator of an FTD shall demonstrate his capability to maintain the performance, functions and other characteristics specified for the FTD Qualification Level:

(a) *Quality system.*

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

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

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

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

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

(1) *Helicopter modifications.* Helicopter modifications whether or not enforced by an airworthiness directive, and which are essential for training and checking shall be introduced into all affected Flight Training Devices.

(2) Modification of STD, including motion systems (if applicable):

(i) Where applicable and essential for training and checking, STD operators shall update their Flight Training Devices (for example in the light of data

revisions). Modifications of the STD hardware and software which affect flight, ground handling and performance or any major modifications of the visual or addition/removal of a motion system (if applicable) shall be evaluated to determine the impact on the original qualification criteria if necessary. STD operators shall prepare amendments for any affected validation test. The STD operator shall test the STD to the new criteria.

(ii) The Authority shall be advised in advance of any major changes to determine whether or not a special evaluation of the STD may be necessary prior to returning it to training following the modification.

(c) *Installations.* Ensure that the FTD is located in a suitable environment, which supports safe and reliable operation.

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

(i) STD occupants and maintenance personnel shall receive adequate briefing on FTD safety.

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

(iii) Adequate protection against electrical, mechanical, hydraulic and pneumatic hazards - including those arising from the control loading & motion systems (if applicable).

(iv) Other items:

(A) Emergency lighting.

(B) Escape exits & facilities.

(C) Danger area markings.

(D) Guard rails and gates.

(E) Control loading emergency stop controls (if applicable) accessible from either pilot and instructor seats.

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

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

(d) *Additional Equipment.* Where additional equipment including motion or visual system has been added by the STD operator to an FTD, even though not required for qualification, it will be assessed to ensure that it does not adversely affect the quality of training. Therefore any subsequent modification, removal or unserviceability could affect the qualification of the device.

YCAR-STD 2H.030 Requirements for FTD qualified on or after 1 January 2005

(See Appendices 1 & 2 to YCAR-STD 2H.030)
(See AC No.1 to YCAR-STD 2H.030)
(See AC No.2 to YCAR-STD 2H.030)

(a) Any FTD submitted for initial evaluation on or after 1 January 2005, will be evaluated against YCAR-STD 2H criteria for Qualification Levels 1, 2 or 3.

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

(1) longitudinal, lateral and directional handling qualities,

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

(3) specific operations where applicable,

(4) flight deck configuration,

(5) functioning during normal, abnormal and emergency operations,

(6) instructor station function and FTD control, and

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

(c) The FTD shall be subjected to:

(1) Validation tests, and

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

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

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

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

(g) The STD operator shall:

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

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

YCAR-STD 2H.035 Intentionally blank

YCAR-STD 2H.040 Changes to qualified FTD

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

(1) Helicopter modifications, which could affect FTD qualification;

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

(3) relocation of the FTD, and

(4) any deactivation of the FTD.

(b) *Upgrade of an FTD.* An FTD may be upgraded to a higher Qualification Level. Special evaluation is required before the issue of a higher level of qualification.

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

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

(c) *Relocation of an FTD.*

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

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

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

(d) *Deactivation of a currently qualified FTD.*

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

(2) The STD operator shall arrange an understanding with the Authority to ensure that the FTD can be restored to active status at its original Qualification Level.

YCAR-STD 2H.045 Interim FTD Qualification

(See AC No.1 to YCAR-STD 2H.045)
(See AC No.2 to YCAR-STD 2H.045)

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

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

YCAR-STD 2H.050 Transferability of FTD Qualification

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

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

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

Appendix 1 to YCAR-STD 2H.030
Technical requirements

(a) This Appendix describes the minimum technical requirements for qualifying FTD Levels 1, 2 and 3.

(b) Each of these Qualification Levels YCARries an appropriate technical description.

(c) Convertible FTD shall be qualified in each configuration.

(d) Specific requirements for the use of the FTD are determined by the Authority. Specialised training courses require an adequate standard of simulation, which will be evaluated by the Authority. (See YCAR-Part 2 and YCAR-OPS).

(e) Credits are granted in accordance with YCAR-Part 2 and YCAR-OPS.

(f) Where additional equipment has been added to an FTD even though not required for qualification, it will be assessed to ensure that it does not adversely affect the qualification of a training device. Any subsequent removal or unserviceability could affect the qualification of the device.

Table 1 - Minimum FTD requirements for qualifying FTD level 1

Qualification Level	General Technical Requirements	Credits
1	Type specific with at least one system fully represented to support the training task required. A cockpit/flight-deck, sufficiently closed off to exclude distractions. A full size panel of replicated system or systems with functional controls and switches. Lighting environment for panels and instruments sufficient for the operation being conducted. Flight-deck circuit breakers located as per the helicopter and functioning accurately for the system(s) represented. Aerodynamic and environment modelling sufficient to permit accurate systems operation and indication. Navigational data with corresponding approach facilities where replicated. Suitable seating arrangements for the instructor/examiner and Authority's inspector. Proper system(s) operation resulting from management by the flight crew independent from instructor control inputs. Instructor's controls to insert abnormal or emergency conditions into the helicopter systems. Independent freeze and reset facilities. Appropriate control forces and control travel. Appropriate flight deck sounds.	Could be considered suitable for: – Selective system management credits (except for pilot manual control handling skills) as follows: • part of an approved conversion/transition course, • recurrent training/checking.

Table 2 - Minimum FTD requirements for qualifying FTD level 2

Qualification Level	General Technical Requirements	Credits
2	As for level 1 with the following additions or amendments: – All systems fully represented. – Lighting environment as per helicopter. – Representative / generic aerodynamic data tailored to the specific helicopter with the fidelity to meet the objective tests. – Adjustable crewmember seats. – Flight control characteristics representative of the helicopter. – A visual system (night/dusk and day) capable of providing a field-of-view of a minimum of 150 degrees horizontally from the middle eye point and 40 degrees vertically – A visual data base sufficient to support the training requirements – Significant flight deck sounds. – On board Instructor station with control of atmospheric conditions and freeze and reset.	Could be considered suitable for: – Type training, including systems management, initial and recurrent training, – Instrument training and IR revalidation/renewal – Recency – CRM Training, as part of approved course. – LOFT (Route and area familiarisation) – MCC training

Table 3 - Minimum FTD requirements for qualifying FTD level 3

Qualification Level	General Technical Requirements	Credits
3	As for level 2 with the following additions or amendments: – Validation flight test data as the basis for objective testing of flight, performance and systems characteristics – Visual system (night/dusk/day) capable of providing a field of view of a minimum of 150 degrees horizontally from the middle eye point and 60 degrees vertically.	Could be considered suitable for: – Type training, testing and checking within an approved testing and checking programme.

Table 4 - Minimum FTD Level 2/3 requirements for MCC

Level 2 and 3 FTD, meeting the following requirements, may seek accreditation for MCC training.

Appendix 2 to YCAR-STD 2H.030
FTD Standards

1. FTD standards

1.2 General

Tests and/or Statements of Compliance (SOC) shall demonstrate that the FTD standards below have been attained. These standards always refer to the type of helicopter being simulated.

FTD STANDARDS		FTD Level			COMPLIANCE
		1	2	3	
a.	A cockpit/flight deck, sufficiently closed off to exclude distractions.	✓	✓	✓	
	A full size panel of replicated system(s) with functional controls and switches. The use of electronically displayed images with physical overlay incorporating operable switches, knobs, buttons may be acceptable.	✓	✓	✓	
b.	Lighting environment for panels and instruments shall be sufficient for the operation being conducted.	✓			
	Lighting environment shall be as per the helicopter.		✓	✓	
c.	Relevant flight deck 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.	✓	✓	✓	
d.	Aerodynamic and environment modelling shall be sufficient to permit accurate systems operation and indication.	✓			Level 1 and 2 aerodynamic data can be representative/generic and need not necessarily be based on flight test data.
	Representative/generic aerodynamic data tailored to the specific helicopter with fidelity sufficient to meet the objective tests and sufficient to permit accurate system operation and indication.		✓		
	Validation flight test data shall be used as the basis for flight and performance and systems characteristics.			✓	
	Effect of aerodynamic changes for various combinations of airspeed and power normally encountered in flight, including the effect of change in helicopter attitude, side slip, altitude, temperature, initial mass, centre of gravity location, and configuration shall be provided.		✓	✓	
e.	Digital or analogue computing shall be sufficient to conduct complete operation of the device including its evaluation and testing.	✓	✓	✓	Statement of Compliance required
f.	All relevant instrument indications involved in the simulation shall	✓	✓	✓	

FTD STANDARDS		FTD Level 1	FTD Level 2	FTD Level 3	COMPLIANCE
	automatically respond to control input.				
g.	Where navigation equipment is replicated, navigational data with the corresponding approach facilities shall be provided. All navigation aids shall be usable within range without restriction. Navigational data shall be capable of being updated.	✓	✓	✓	.
h.	Crewmember seats shall afford the capability for the occupants to be able to achieve the design eye reference position.	✓	✓	✓	
i.	In addition to the flight crewmember stations, suitable seating arrangements for the instructor/examiner and Authority's inspector shall be provided, which shall permit adequate view of crew members' panel(s).	✓	✓	✓	
j.	Any system represented shall be fully operative to the extent that normal, abnormal and emergency operating procedures can be accomplished at the appropriate FTD level. Once activated, proper system operation shall result from system management by the flight crew and not require input from instructor controls.	✓	✓	✓	
k.	Instructor's controls shall enable the STD operator to control all required system variables and insert abnormal or emergency conditions into the helicopter systems, as specified in the helicopter Flight Manual. Independent freeze and reset facilities shall be provided. Instructor controls to vary atmospheric conditions shall be provided.	✓	✓ ✓	✓ ✓	
l.	Representative control forces and control travel shall be provided.	✓	✓	✓	For FTD level 1 as appropriate for the system training required
m.	Significant flight deck sounds shall be provided.	✓	✓	✓	For FTD level 1 as appropriate for the system training required
n.	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.		✓	✓	SOC
o.	Relative response of the visual system and cockpit instruments should be coupled closely to provide integrated sensory cues. These systems should respond to abrupt pitch, roll, and yaw inputs at the pilot's position within the permissible delay.	✓	✓	✓	For Level 1 only instrument response is required.
p.	A system allowing for timely continuous updating of FTD hardware and programming consistent with helicopter modifications.	✓	✓	✓	SOC

FTD STANDARDS	FTD Level 1	FTD Level 2	FTD Level 3	COMPLIANCE
q. The STD operator shall submit a Qualification Test Guide in a form and manner acceptable to the Authority. A recording system shall be provided that will enable the FTD performance to be compared with QTG criteria.	✓	✓	✓	
r. A means of quickly and effectively testing FTD programming and hardware	✓	✓	✓	Statement of compliance required
s. FTD computer capacity and accuracy resolution and dynamic response sufficient for the Qualification Level sought.	✓	✓	✓	Statement of compliance required

1.3 Visual system

FTD STANDARDS	FTD Level 1	FTD Level 2	FTD Level 3	COMPLIANCE
a. 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 STD operator.		✓	✓	
b. Continuous minimum visual field of view of 150 degrees horizontal and 40 degrees vertical available to both pilots.		✓		A minimum of 75 degrees of horizontal field of view on either side of the zero degrees azimuth line relative to the helicopter fuselage is required.
Continuous minimum visual field of view of 150 degrees horizontal and 60 degrees vertical available to both pilots.			✓	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, in accordance with YCAR-Part 2 2/YCAR-OPS 3 subpart N, require extended fields of view beyond the 150 degrees x 60 degrees, then such extended fields of view should be provided.
c. A means of recording the visual response time for visual systems		✓	✓	

FTD STANDARDS	FTD Level 1	FTD Level 2	FTD Level 3	COMPLIANCE
d. Verification of visual ground segment and visual scene content at a decision height on landing approach. The QTG shall contain appropriate calculations and a drawing showing the pertinent data used to establish the helicopter location and visual ground segment. Such data shall include, but are not limited to: (1) Aerodrome and runway used. (2) Glide slope transmitter location for the specified runway. (3) Position of the glide slope receiver antenna relative to the helicopter landing gear. (4) Approach and runway light intensity settings. (5) Helicopter attitude. The above parameters should be presented for the helicopter in the landing configuration and a landing gear height of 200ft (60m) above the touchdown zone. The visual ground segment and scene content should be determined for a runway visual range of 550m (1 805 ft).		✓	✓	See the respective paragraph within the tables of validation tests as well as functions and subjective tests.
e. Visual cues to assess rate of change of height and position during takeoff, low altitude/low airspeed manoeuvring, hover and landing.		✓	✓	
f. Test procedures to quickly confirm visual system colour, RVR, focus, intensity, level horizon, and attitude as compared with the specified parameter.		✓	✓	Statement of Compliance required. Tests required. See the respective paragraph within the tables of validation tests as well as functions and subjective tests.
g. Night/Dusk/Day scene		✓	✓	
h. A minimum of 10 levels of occulting. This capability should be demonstrated by a visual model through each channel.		✓	✓	Statement of Compliance required. Tests required. See the respective paragraph within the tables of validation tests as well as functions and subjective tests.
i. Surface resolution will be demonstrated by a test pattern of objects shown to occupy a visual angle of 3 arc minutes in the visual scene from the pilot's eyepoint.		✓	✓	Statement of compliance required to confirm that surface resolution has been measured at each pilot's eye position towards the middle of each channel. See the respective paragraph within the tables of validation tests as well as functions and subjective tests.

FTD STANDARDS	FTD Level			COMPLIANCE
	1	2	3	
j. Light point size not greater than 6 arc minutes measured in a test pattern consisting of a single row of light points, separated by black points, reduced in length until modulation is just discernable. A row of 30 lights will form a 4 degree angle or less.		✓	✓	This is equivalent to a light point resolution of 3 arc minutes. See the respective paragraph within the tables of validation tests as well as functions and subjective tests.
k. A visual database sufficient to support the requirements, including		✓	✓	Generic database is acceptable.
(i) Specific areas within the database needing higher resolution to support landings, take-offs and ground cushion exercises and training away from a heliport.				Where applicable
(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.				Where applicable
(iii) For offshore airborne radar approaches (ARA), harmonised visual/radar representations of installations.				Where applicable
(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 ambient light/colour.				Where applicable
Detailed high resolution visual data bases as required to support advanced training, including at least: - elevated heliports (including heli-decks), confined areas.				Where applicable
l. The visual system should be capable of producing, as a minimum, the following effects: (1) full colour presentations. Full colour texture should be used to enhance visual cue perception for illuminated landing surfaces. (2) scene content comparable in detail with that produced by 6 000 polygons for daylight and 1 000 light points for night and dusk scenes for the entire visual system, (3) 17 cd/m² (5 ft-Lamberts) of light measured at the pilot's eye position (Highlight Brightness), (4) a display which is free of apparent quantization and other distracting visual effects.		✓	✓	Statement of Compliance required. Test required The ambient lighting should provide an even level of illumination which is not distracting to the pilot. See the respective paragraph within the tables of validation tests and functions and subjective tests.

FTD STANDARDS		FTD Level			COMPLIANCE
		1	2	3	
m.	Contrast Ratio. A raster drawn test pattern filling the entire visual scene (three or more channels) should consist of a central white square no larger than 10 degrees and no smaller than 5 degrees per channel. Minimum test contrast ratio is 8:1.		✓	✓	Measurement should be made on the centre of the white square and the adjacent dark area for each channel using a 1 degree spot photometer. The contrast ratio is the value of the white square divided by the value of the dark area.
n.	Highlight Brightness Test. The minimum highlight brightness is 5 ft-Lamberts.		✓	✓	Measure the brightness of the centre of a white square covering 10% of the surface of each channel using the 1 degree spot photometer.

SECTION 2 – ADVISORY CIRCULARS (AC)

1 GENERAL

1.1 This Section contains Advisory Circulars (AC) providing acceptable means of compliance and/or interpretative/explanatory material that have been agreed for inclusion in YCAR–STD 2H.

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

2 PRESENTATION

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

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

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

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

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

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

AC B - GENERAL

AC YCAR-STD 2H.005
Terminology, Abbreviations
See YCAR-STD 2H.005

1. Terminology

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

a. Automatic Testing. STD testing wherein all stimuli are under computer control.

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

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

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

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

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

g. Damping (critical, over-damped, under-damped).

The CRITICAL DAMPING is that minimum damping of a second order system such that no overshoot occurs in reaching a steady state value after being displaced from a position of equilibrium and released. This corresponds to a relative damping ratio of 1·0.

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.

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.

h. 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.

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

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

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

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

m. Functions Test. A quantitative assessment of the operation and performance of an STD by a suitably qualified evaluator. The test can include verification of correct operation of controls, instruments, and systems of the simulated helicopter under normal, abnormal, emergency and, where applicable, 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.

n. Grandfather Rights.

(i) The right of an STD operator to maintain the Qualification Level granted under a previous regulation of an ICAO state.

(ii) Also the right of an STD user to maintain the training and testing/checking credits which were gained under a previous regulation of an ICAO state.

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

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

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

r. Highlight Brightness. The maximum displayed brightness which satisfies the brightness test as described under FTD standards.

s. Icing Accountability. A demonstration of minimum required performance whilst operating in maximum and intermittent maximum icing conditions of the applicable airworthiness requirement.

t. Integrated Testing. Testing of the STD such that all helicopter system models are active and contribute appropriately to the results. None of the helicopter system models should be substituted with models or other algorithms intended for testing only. This may be accomplished by using controller displacements as the input. These controllers should represent the displacement of the pilot's controls and these controls should have been calibrated.

u. Irreversible Control System. A control system in which movement of the control surface will not back-drive the pilot's control on the flight deck.

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

w. 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.

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

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

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

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

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

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

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

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

ff. Reversible Control System. A control system in which movement of the control surface will back-drive the pilot's control on the flight deck.

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

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

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

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

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

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

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

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

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

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

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

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

ss. Visual System Response Time. The interval from an abrupt control input to the completion of the visual display scan of the first video field containing the resulting different information.

2. Abbreviations

AC	=	Advisory Circular
AC	=	Advisory Circular Joint
AFM	=	Approved Flight Manual
AGL	=	Above Ground Level (meters or feet)
Airspeed	=	Calibrated airspeed unless otherwise specified (knots)
Altitude	=	Pressure altitude (meters or feet) unless specified otherwise
AOA	=	Angle of Attack (degrees)
Ad	=	Total initial displacement of pilot controller (initial displacement to final resting amplitude)
An	=	Sequential amplitude of overshoot after initial X axis crossing, e.g. A1 = 1st overshoot.
Bank	=	Bank/Roll angle (degrees)
cd/m2	=	candela/meter^2, 3·4263 candela/m2 = 1 ft-Lambert
cm(s)	=	centimetre(s)
CT&M	=	Correct Trend and Magnitude
daN	=	decaNewtons
deg(s)	=	degree, degrees
distance	=	distance in nautical miles unless specified otherwise
DME	=	Distance Measuring Equipment
EPR	=	Engine Pressure Ratio
FAA	=	Federal Aviation Administration (U.S.)
ft	=	feet, 1 foot = 0·304801 meters
ft-Lambert	=	foot-Lambert, 1 ft-Lambert = 3·4263 candela/m^2
fuel used	=	Mass of fuel used (kilos or pounds)
g	=	Acceleration due to gravity (meters or feet/sec^2), 1g = 9·81 m/sec^2 or 32·2 feet/sec^2
G/S	=	Glide slope

Height	=	Height above ground = AGL (meters or feet)
IATA	=	International Air Transport Association
ICAO	=	International Civil Aviation Organisation
IGE	=	In Ground Effect
ILS	=	Instrument Landing System
IOS	=	Instructor Operating Station
IQTG	=	International Qualification Test Guide (RAeS document)
km	=	Kilometres 1 km = 0·62137 Statute Miles
kPa	=	Kilo Pascal (Kilo Newton/Meters^2). 1 psi = 6·89476 kPa
kts	=	Knots calibrated airspeed unless otherwise specified, 1 Knot = 0·5148 m/sec or 1·689 ft/sec
lb	=	pounds
m	=	Metres, 1 Meter = 3·28083 feet
MCC	=	Multi-Crew Co-operation
Medium	=	Normal operational weight for flight segment
min	=	Minutes
MLG	=	Main Landing Gear
MPa	=	Mega Pascals [1 psi = 6894·76 pascals]
ms	=	millisecond(s)
MTOM	=	Maximum Take-Off Mass
NM	=	Nautical Mile 1 Nautical Mile = 6 080 feet
Nominal	=	Normal operational weight, configuration, speed, etc, for the flight segment specified
N1	=	Engine low pressure rotor revolutions per minute
N2	=	Engine high pressure rotor revolutions per minute
NWA	=	Nose Wheel Angle (degrees)
n	=	sequential period of a full cycle of oscillation
OGE	=	Out of Ground Effect
PAPI	=	Precision Approach Path Indicator System
Pitch	=	Pitch angle (degrees)
PLA	=	Power Lever Angle
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
Pn	=	Sequential period of oscillation
Pf	=	Impact or Feel Pressure
PLF	=	Power for Level Flight
psi	=	pounds per square inch
QTG	=	Qualification Test Guide
RAE	=	Royal Aerospace Establishment
RAeS	=	Royal Aeronautical Society
REIL	=	Runway End Identifier Lights
R/C	=	Rate of Climb (meters/sec or feet/min)
R/D	=	Rate of Descent (meters/sec or feet/min)
RVR	=	Runway Visual Range (meters or feet)
s	=	second(s)
sec(s)	=	second, seconds
sm	=	Statute Miles 1 Statute Mile = 5 280 feet
SOC	=	Statement of Compliance
STD	=	Synthetic Training Device

T(A)	=	Tolerance applied to Amplitude
T(P)	=	Tolerance applied to Period
T/O	=	Takeoff
Tf	=	Total time of the flare manoeuvre duration
Ti	=	Total time from initial throttle movement until a 10% response of a critical engine parameter
Tt	=	Total time from Ti to a 90% increase or decrease in the power level specified
VASI	=	Visual Approach Slope Indicator System
VGS	=	Visual Ground Segment
WAT	=	Weight, Altitude, Temperature

AC C - HELICOPTER FLIGHT TRAINING DEVICES

AC No. 1 to YCAR-STD 2H.015 (acceptable means of compliance)
FTD Qualification - Application and Evaluation
(See AC No.2 to YCAR-STD 2H.015)

1 Letter of Application

A sample of letter of application is provided overleaf.

LETTER OF APPLICATION FOR INITIAL EVALUATION OF A FLIGHT TRAINING DEVICE

(Date) ....

PRINCIPAL INSPECTOR
(Address)

(City)

(Country)

Dear

....................(name of applicant)........................ requests the evaluation of its ......(type)..... Flight Training Device for Level ....(1, 2 or 3) qualification. The ......(STD manufacturer name) FTD with its ....(visual system manufacturer name) visual system is fully defined on page .... of the accompanying Qualification Test Guide (QTG) which was run on ....(date)......... at ....(place)....... We have completed tests of the FTD and declare that it meets all applicable requirements of the YCAR-STD 2H (helicopter FTD) except as noted below. Appropriate hardware and software configuration control procedures have been established and these are appended for your inspection and approval.

The FTD has been assessed by the following evaluation team:

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

who attest(s) that it conforms to the helicopter flight deck configuration of ....(name of operator)..........(type of 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 FTD and finds that it represents the designated helicopter.

(additional comments as required)

The following tests are outstanding:

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

Sincerely,

Print Name
Position/Appointment held

2 Composition of evaluation team

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

a. A Technical FTD Inspector of the Authority, qualified in all aspects of flight simulation hardware, software and computer modelling.

b. A Flight Inspector of the Authority who is qualified in flight crew training procedures and type rated on the helicopter.

Exceptionally, where either a Technical FTD Inspector or a type rated Flight Inspector is not available, an Authority designee may be used.

2.2 Additionally the following persons should be present:

a. A type rated Training Captain typically from the FTD operator or main FTD users.

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

AC No.2 to YCAR-STD 2H.015 (acceptable means of compliance)
FTD Evaluations
See YCAR-STD 2H.015

1 General

1.1 During initial and recurrent STD evaluations it will be necessary for the Authority to conduct the objective and subjective tests described in YCAR-STD 2H.030 and detailed in AC No. 1 to YCAR-STD 2H.030. There will be occasions when all tests cannot be completed - for example during recurrent evaluations on a convertible FTD - but arrangements should be made for all tests to be completed within a reasonable time.

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

2 Initial Evaluations

2.1 Objective Testing

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

2.1.2 Much of the time allocated to objective tests depends upon the speed of the automatic and manual systems set up to run each test and whether or not special equipment is required. The Authority will not necessarily warn the FTD 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 FTD cannot be used for Subjective Tests whilst part of the QTG is being run. Therefore sufficient time 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 AC No.1 to YCAR- STD 2H.030, and a suggested Subjective Test Profile is described in AC No 2 to YCAR- STD 2H.015 paragraph 4.6.

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

2.3 Conclusion

To ensure adequate coverage of subjective and objective tests and to allow for cost effective rectification and re-test before departure of the inspection team, up to three consecutive days should be dedicated to an initial evaluation of an FTD.

3 Recurrent Evaluations

3.1 Objective Testing

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

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

3.2 Subjective testing

3.2.1 Essentially the same subjective test routine should be flown as per the profile described in AC No.2 to YCAR-STD 2H.015 para 4.6 with a selection of the subjective tests taken from AC YCAR-STD 2H.030.

3.2.2 Normally, the time taken for recurrent subjective testing is about four (4) hours, and the FTD cannot perform other functions during this time.

3.3 Conclusion

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

4 Functions and Subjective Tests - Suggested Test Routine

4.1 During initial and recurrent evaluations of an STD, the competent Authority will conduct a series of functions and subjective tests, which together with the objective tests complete the comparison of the STD with the helicopter.

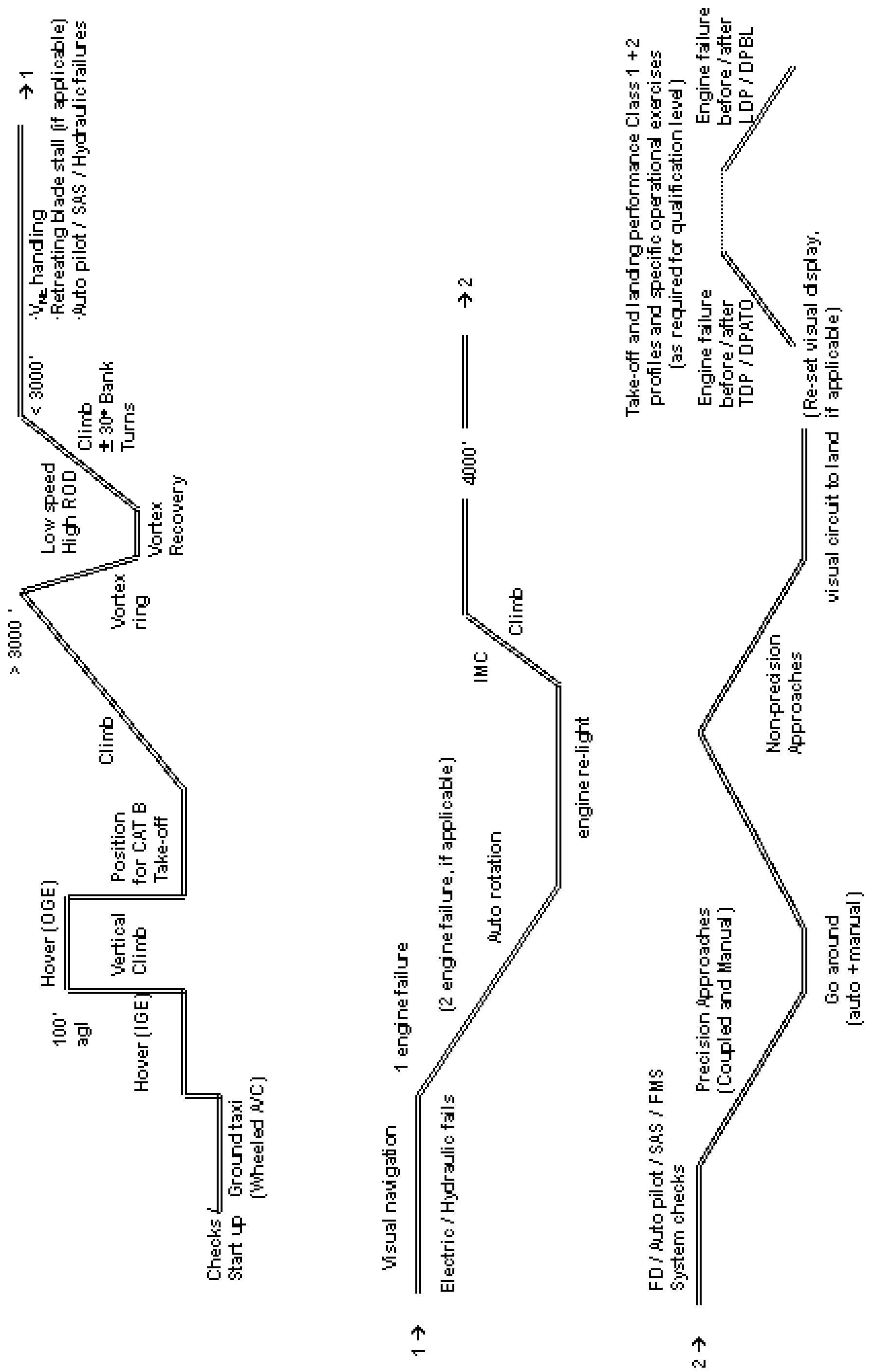
4.2 Whereas functions tests verify the acceptability of the simulated helicopter systems and their integration, subjective tests verify the fitness of the STD in relation to training, checking and testing tasks.

4.3 The STD 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 operation of the Instructor Operating Station (IOS) should be simple enough to give the instructor spare capacity to observe the activities of the flight crew.

4.4 Section One of YCAR-STD 2H sets out the requirements, and the ACs in Section Two the means of compliance for FTD qualification. However, it is important that both the Authority and the STD operator understand what to expect from the routine of STD functions and subjective tests. It should be remembered that part of the subjective tests routine for an FTD Level 2 or 3 should involve an uninterrupted fly-out comparable with the duration of typical training sessions in addition to assessment of flight freeze and repositioning. An example of such a profile is to be found in para. 4.6 below.

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

4.6 Typical Test Profile for an FTD level 2 or 3 (2 hours).



Note: The Typical Test Profile should be flown at helicopter masses at, or close to, the maximum allowable mass for the ambient atmospheric conditions. Those ambient conditions should be varied from Standard Atmosphere to test the validity of the limits of temperature and pressure likely to be required in the practical use of the STD. Visual exercises apply to FTD 2 and 3 only.

AC No. 1 to YCAR-STD 2H.025 (acceptable means of compliance)
STD Operator's Quality System
See YCAR-STD 2H.025

1 Introduction

1.1 In order to show compliance with YCAR-STD 2H.025, an STD operator should establish his Quality System in accordance with the instructions and information contained in the following paragraphs.

2 General

2.1 Terminology

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

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

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

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

2.2 Quality Policy

2.2.1 An STD operator should establish a formal written Quality Policy Statement that is a commitment by the Accountable Manager as to what the Quality System is intended to achieve. The Quality Policy should reflect the achievement and continued compliance with YCAR-STD 2H together with any additional standards specified by the STD operator.

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

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

2.2 Purpose of the Quality System

2.3.1 The Quality System should enable the operator to monitor compliance with YCAR-STD 2H, and any other standards specified by that STD operator, or the Authority, to ensure correct maintenance and performance of the device.

2.4 Quality Manager

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

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

2.4.3 The Quality Manager should:

a. Have direct access to the Accountable Manager;

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

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

3 Quality System

3.1 Introduction

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

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

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

3.2 Scope

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

a. The provisions of YCAR-STD 2H;

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

c. The STD operator's Quality Policy;

d. The STD operator's organisational structure;

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

f. Documentation, including manuals, reports and records;

g. Quality Procedures;

h. Quality Assurance Programme;

i. The required financial, material, and human resources;

j. Training requirements.

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

3.3 Relevant Documentation

3.3.1 Relevant documentation should include the following:

a. Quality Policy;

b. Terminology;

c. Reference to specified STD technical standards;

d. A description of the organisation;

e. The allocation of duties and responsibilities;

f. Qualification procedures to ensure regulatory compliance;

g. The Quality Assurance Programme, reflecting:

(i) Schedule of the monitoring process;

(ii) Audit procedures;

(iii) Reporting procedures;

(iv) Follow-up and corrective action procedures;
(v) Recording system;

h. Document control.

4 Quality Assurance Programme

4.1 Introduction

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

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

4.2 Quality Inspection

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

4.2.2 Typical subject areas for quality inspections are:

a. Actual STD operation;

b. Maintenance;

c. Technical Standards;

d. Simulator Safety Features;

4.3 Audit

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

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

a. A statement explaining the scope of the audit;

b. Planning and preparation;

c. Gathering and recording evidence; and

d. Analysis of the evidence.

4.3.3 Techniques which contribute to an effective audit are:

a. Interviews or discussions with personnel;

b. A review of published documents;

c. The examination of an adequate sample of records;

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

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

4.4 Auditors

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

have relevant STD experience (e.g. a pilot who is qualified on the appropriate type or class of helicopter/a person qualified in STD operation methods).

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

4.5 Auditor's Independence

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

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

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

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

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

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

e. Report directly to the Quality Manager.

4.6 Audit Scope

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

a. Organisation;

b. Plans and objectives;

c. Maintenance Procedures;

d. STD Qualification Level;

e. Supervision;

f. STD technical status;

g. Manuals, Logs, and Records;

h. Defect Deferral;

i. Personnel Training;

j. Helicopter Modification Management;

4.7 Audit Scheduling

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

4.7.2 An STD operator should establish a schedule of audits to be completed during a specified calendar period. All aspects of the operation should be reviewed within every period of 12 months in accordance

with the programme unless an extension to the audit period is accepted as explained below. An operator may increase the frequency of audits at his discretion but should not decrease the frequency without the agreement of the Authority.

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

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

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

4.8 Monitoring and Corrective Action

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

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

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

4.8.4 Corrective action

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

(i) The seriousness of any findings and any need for immediate corrective action;

(ii) Cause of the finding;

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

(iv) A schedule for corrective action;

(v) The identification of individuals or departments responsible for implementing corrective action;

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

4.8.5 The Quality Manager should:

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

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

c. Monitor the implementation and completion of corrective action;

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

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

4.9 Management Evaluation

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

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

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

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

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

4.10 Recording

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

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

a. Audit Schedules;

b. Quality inspection and Audit reports;

c. Responses to findings;

d. Corrective action reports;

e. Follow-up and closure reports; and
f. Management Evaluation reports.

5 Quality Assurance responsibility for sub-contractors

5.1 Sub-contractors

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

a. Maintenance;

b. Manual preparation.

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

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

6 Quality System Training

6.1 General

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

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

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

b. Quality management;

c. Concept of Quality Assurance;

d. Quality manuals;

e. Audit techniques;

f. Reporting and recording; and

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

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

6.2 Sources of Training

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

AC No 2 to YCAR-STD 2H.025 (explanatory material)
Additional Equipment
See YCAR-STD 2H.025

1 Motion

1.1 Although motion is not a requirement for an FTD, should the STD operator choose to have one fitted, it will be evaluated to ensure that its contribution to the overall fidelity of the device is not negative. The following text is copied from YCAR-STD 1H for information.

1.2 For Level A flight simulators, the requirements for both the primary cueing and buffet simulation have been not specified in detail. Traditionally, for primary cueing, emphasis has been laid on the numbers of axes available on the motion system. For this level of flight simulator, it is felt appropriate that the simulator manufacturer should be allowed to decide on the complexity of the motion system. However, during the evaluation, the motion system will be assessed subjectively to ensure that it is supporting the piloting task, including engine failures, and is in no way providing negative cueing.

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

1.4 The motion system transport delay should meet the standards prescribed for the visual display and cockpit instrument response.

AC No. 1 to YCAR-STD 2H.030 (acceptable means of compliance)
FTD qualified on or after 1 January 2005
See YCAR-STD 2H.030

Note: The structure and numbering of this AC departs from normal layout due to the complexity of the technical content and the need to retain harmonisation with YCAR-STD 1H and YCAR-STD 3H.

1 Introduction

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

1.2 Background

1.2.1 The availability of advanced technology has permitted greater use of FTD for training, testing and checking of flight crew members. The complexity, costs and operating environments of modern helicopters also encourage broader use of advanced simulation. FTD can provide more in-depth training than can be accomplished in helicopters and provide a safe and suitable learning environment.

1.2.2 The methods, procedures, and testing standards contained in this AC are the result of the experience and expertise of Authorities, operators and manufacturers of helicopters and STDs (FS, FTD and FNPT).

1.3 Levels of FTD Qualification. Paragraphs 2 and 3 of this AC describe the minimum requirements for qualifying Level 1, 2 and 3 helicopter FTD.

Note: Where an FTD Level 1 simulates a helicopter system, it should comply with the subjective and objective tests relevant to that system.

1.4 Terminology. Terminology and abbreviations of terms as used in this AC are contained in AC YCAR-STD 2H.005.

1.5 Testing for FTD Qualification

1.5.1 The FTD should be assessed in those areas, which are essential to completing the flight crew member training, testing and checking process. This includes the FTD's specific operations, control checks, flight deck and instructor station functions checks, and certain additional requirements depending on the complexity or Qualification Level of the FTD. The motion system and visual system where fitted additional to specific FTD requirements will be assessed to ensure that they do not adversely affect the qualification of the FTD.

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

1.5.3 Tolerances listed for parameters in the validation tests (paragraph 2) of this AC should not be confused with FTD design tolerances. Validation test tolerances are the maximum acceptable for FTD qualification.

1.5.4 For initial qualification testing of FTD the helicopter approved data is preferred. Data from other sources may be used, subject to the review and concurrence of the Authority.

1.5.5 In the case of new helicopter programmes, the helicopter manufacturer's predicted data partially validated may be used in the interim qualification of the FTD. However, the FTD should be re-evaluated following the release of the manufacturer's approved data. The schedule should be as agreed by the Authority, STD operator, STD manufacturer, and helicopter manufacturer.

1.5.6 During FTD evaluation, if a problem is encountered with a particular validation test, the test may be repeated to ascertain if the problem was caused by test equipment or STD operator error. Following this, if the test problem persists an STD operator should be prepared to offer an alternative test.

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

1.6 Qualification Test Guide (QTG)

1.6.1 The QTG is the primary reference document used for evaluating an FTD. It contains test results, Statements of Compliance and other information for the evaluator to assess if the FTD meets the test criteria described in this AC.

1.6.2 The STD operator should submit a QTG which includes:

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

b. An FTD information page (for each configuration in the case of convertible FTDs) providing:

i. STD operator's FTD identification number.

ii. Helicopter model and series being simulated.

iii. Aerodynamic data revision.

iv. Engine model and its data revision.

v. Avionic equipment system identification where the revision level affects the training and checking capability of the FTD.

vi. FTD model and manufacturer.

vii. Date of FTD manufacture.

viii. FTD computer identification.

ix. Visual system type and manufacturer (if fitted/applicable).

x. Motion system type and manufacturer (if fitted).

c. Table of contents.

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

e. Listing of all reference and source data.

f. Glossary of terms and symbols used.

g. Statements of Compliance (SOC) with certain requirements. SOC 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.

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

i. The following items for each Validation Test designated in paragraph 2 of this AC:

i. Test Title. This should be short and definitive, based on the test title referred to in AC YCAR-STD 2H.030 paragraph 2.

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

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

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

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

vi. Manual test procedures. Procedures should be sufficient to enable the test to be flown by a qualified pilot (or qualified inspector for FTD 1), using reference to flight deck instrumentation and without reference to other parts of the QTG or Flight Test Data.

vii. Automatic test procedures (if applicable).

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

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

x. Test result. Dated FTD Validation Test results obtained by the FTD operator. Tests run on a computer, which is independent of the FTD, are not acceptable.

xi. Source data. Copy of the helicopter source data, clearly marked with the document, page number, issuing authority, and the test number and title as specified in i. above. Computer generated displays of Flight Test Data over-plotted with FTD data are insufficient on their own for this requirement.

xii. Comparison of results. An acceptable means of easily comparing FTD test results with the validation flight test data. The preferred method is over-plotting.

j. A Statement of Compliance (SOC) covering the Functions and Subjective Tests designated

in paragraph 3 below.

Note: The STD operator's FTD test results should be recorded on a multi channel recorder, line printer, or other appropriate recording media acceptable to the Authority conducting the test. FTD test results should be labelled using terminology common to helicopter parameters as opposed to computer software identifications. These results should be easily compared with the supporting data by employing cross plotting, overlay transparencies, or other acceptable means. Helicopter data documents included in the QTG may be photographically reduced only if such reduction will not alter the graphic scaling or cause difficulties in scale interpretation or resolution. Incremental scales on graphical presentations should provide resolution necessary for evaluation of the parameters shown in AC STD 2H.030-2. The test guide will provide the documented proof of compliance with the FTD validation tests in AC STD 2H.030-2. For tests involving time histories, flight test data sheets or transparencies thereof and, FTD test results should be clearly marked with appropriate reference points to ensure an accurate comparison between the FTD and helicopter with respect to time. STD operators using line printers to record time histories should clearly mark that information taken from line printer data output for cross-plotting on the helicopter data. The cross plotting of the STD operator's FTD data to helicopter data is essential to verify FTD's performance in each test. The evaluation serves to validate the STD operator's FTD test results.

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

1.8 Procedures for initial FTD Qualification

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

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

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

1.9 FTD recurrent qualification basis

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

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

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

2 FTD Validation Tests

2.1 Discussion

2.1.1 FTD performance and system operation should be objectively evaluated by comparing the results of tests conducted in the FTD with helicopter data unless specifically noted otherwise. To facilitate the validation of the FTD, a multi-channel recorder, line printer, or other appropriate recording device acceptable to the Authority is preferred to record each validation test result. These recordings should then be compared with the following approved source data:

a. For FTD Levels 1 and 2, this data may include flight manuals, operations manual, performance charts, maintenance manuals, system user guides, as well as video recording of systems logic and performance. This data may be supplemented by any additional theoretically calculated data.

b. For FTD Level 3 data are based on flight test.

2.1.2 Certain tests in this AC are not necessarily based upon validation data with specific tolerances. However, these tests are included here for completeness, and the required criteria must be fulfilled instead of meeting a specific tolerance.

2.1.3 The QTG provided by the STD operator should describe clearly and distinctly how the FTD will be set up and operated for each test. Use of a driver programme designed to automatically accomplish the tests is encouraged. It is not the intent, nor is it acceptable, to test each FTD subsystem independently. Overall Integrated Testing of the FTD must be accomplished to assure that the total FTD system meets the prescribed standards. A test procedure with explicit and detailed steps for completion of each test must also be provided.

2.1.4 The tests and tolerances contained in this AC should be included in the STD operator's QTG.

2.1.5 The table of validation tests of this AC indicates the test requirements. Unless noted otherwise, FTD tests should represent helicopter performance and handling qualities at operating weights and centres of gravity (cg) typical of normal operation. Tests of handling qualities should include validation of stability augmentation and control augmentation devices.

2.1.6 Where extra equipment is fitted, such as a motion system or in an FTD Level 1 a visual system, such equipment is expected to satisfy tests as follows:

a. Visual system: where fitted to an FTD Level 1, validation tests are those specified for an FTD Level 2.

b. Motion system: where fitted to an FTD, validation tests are those specified in YCAR-STD 1H for Level A.

2.1.7 Tests, which ensure stability and repeatability of the FTD's performance against time, should be included. These tests are also indicated in the tables.

2.2 Test requirements

2.2.1 The ground and flight tests required for qualification are listed in the table of validation tests. Computer generated FTD test results should be provided for each test. The results should be produced preferably on a multi-channel recorder, line printer, or other appropriate recording device acceptable to the Authority. Time histories are required unless otherwise indicated in the table of validation tests.

2.2.2 Approved helicopter data which exhibit rapid variations of the measured parameters may require engineering judgment when making assessments of FTD 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 FTD to approved helicopter data throughout a time history, differences should be justified by providing a comparison of other related variables for the condition being assessed.

2.2.2.1 Parameters, tolerances, and flight conditions. The table of validation tests of AC No. 1 to YCAR-STD 2H.030, paragraph 2.4, describes the parameters, tolerances and flight conditions for FTD validation. When two tolerance values are given for a parameter, the less restrictive may be used unless indicated otherwise. 'Where tolerances are expressed only as a percentage, then the percentage of the maximum operating range of a parameter will be used. If a flight condition or operating condition is shown which does not apply to the Qualification Level sought, it should be disregarded. FTD results should be labelled using the tolerances and units specified.

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

2.2.2.3 Where the tolerances have been replaced by "Correct Trend and Magnitude" (CT&M), the FTD should be tested and assessed as representative of the helicopter to the satisfaction of the Authority. To facilitate future evaluations, sufficient parameters should be recorded to establish a reference.

2.3 FTD technical specification

It is essential that a structured process is followed for the initial acceptance and recurrent validation of FTD. To gain and maintain a Qualification Level, the following process should be followed:

a. A design specification is presented to the Authority. The specification should contain a statement of the source data and the target performance of the device in the relevant stages of flight.

b. A proposed QTG should accompany the design specification document.

c. When the device is constructed an acceptance test comprising of objective, functional and subjective tests should be completed. If subjective testing discloses unacceptable flight characteristics, then data package and QTG may be amended to improve handling and performance characteristics.

Following the subjective tuning described in c. above, and a further acceptance test completed by the Authority, the QTG criteria should be frozen to provide criteria against which the device will be assessed (using stated tolerances) to ensure repeatability during recurrent qualification tests.

2.4 Table of Validation Tests

The tolerances listed below are intended for the evaluation of FTD for initial qualification, except where CT&M is indicated. In all cases the tests are intended for use in recurrent evaluations at least to ensure repeatability.

A number of tests within the QTG have had their requirements reduced to "Correct Trend and Magnitude" (CT&M) for initial evaluations thereby avoiding the need for specific validation data. 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 evaluation.

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.

Note 1: It is accepted that tests and associated tolerances will 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 Authority.

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

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL			COMMENTS
			1	2	3	
c. Takeoff						
(1) All engines	Airspeed - ± 3 kt Altitude - ± 20 ft (6·1 m) Torque - ± 3% Rotor Speed - ± 1·5% Pitch Attitude - ± 1·5° Bank Attitude - ± 2° Heading - ± 2° Longitudinal Control Position - ± 10% Lateral Control Position - ± 10% Directional Control Position - ± 10% Collective Control Position - ± 10%	Ground/lift off and initial climb	CT &M	✓	✓	Time history of takeoff flight path as appropriate to helicopter model simulated (running take off for Level 2. Takeoff from a hover for Level 3). For Level 2, criteria apply only to those segments at airspeeds above effective translational lift. Record data to at least 200 ft (61 meters) AGL/Vy whichever comes later
(2) One Engine Inoperative continued take-off	See 1.c. (1) above for tolerances and flight conditions		CT &M	✓	✓	Time history of takeoff flight path as appropriate to helicopter model simulated. Record data to at least 200 ft (61 meters) AGL /Vy whichever comes later
(3) One Engine inoperative rejected take off	Airspeed - ± 3 kt Altitude - ± 20 ft (6·1 m) Torque - ± 3% Rotor Speed - ± 1·5% Pitch Attitude - ± 1·5° Bank Attitude - ± 1·5° Heading ± 2° Longitudinal Control Position - ± 10% Lateral Control Position - ± 10% Directional Control Position - ± 10% Collective Control Position - ± 10% Distance: ± 7·5% or ± 30m (100ft)	Ground/take off	CT &M	✓	✓	Time history from the take off point to touch down. Test conditions near limiting performance.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL 1	LEVEL 2	LEVEL 3	COMMENTS
d. Hover Performance	Torque - ± 3% Pitch Attitude - ± 1·5° Bank Attitude - ± 1·5° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	In Ground Effect (IGE) Out of Ground Effect (OGE)	CT &M	✓	✓	Light/heavy/ gross weights. May be a snapshot test. Refer to point 2.5.2 below for additional guidance.
e. Vertical Climb Performance	Vertical Velocity - ± 100 fpm (0·50 m/sec) or 10% Directional Control Position - ± 5% Collective Control Position - ± 5%	From OGE Hover	CT &M	✓	✓	Light/heavy/ gross weights. May be a snapshot test.
f. Level Flight Performance and Trimmed Flight Control Position	Torque - ± 3% Pitch Attitude - ± 1·5° Sideslip Angle - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	Cruise Stability augmentation on/off	CT &M	✓	✓	Two gross weight/cg and two speed combinations within the flight envelope. May be a snapshot test.
g. Climb Performance and Trimmed Flight Control Position	Vertical Velocity - ± 100 fpm (0·50 m/sec) or 10% Pitch Attitude - ± 1·5° Sideslip Angle - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5% Speed - ± 3kts	All engines operating One engine inoperative Both : Stability augmentation on/off	CT &M	✓	✓	Two gross weight/cg combinations. Data presented at relevant climb power conditions. The achieved measured vertical velocity of the FTD cannot be less than the appropriate Approved Flight Manual values.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL			COMMENTS
			1	2	3	
h. Descent						
(1) Descent Performance and Trimmed Flight Control Position	Torque - ± 3% Pitch Attitude - ± 1·5° Sideslip Angle - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	At or near 1 000 fpm Rate of Descent (RoD) at normal approach speed. Stability augmentation on/off	CT &M	✓	✓	Two gross weight/CG combinations.
(2) Autorotation Performance and Trimmed Flight Control Position	Vertical Velocity - ± 100 fpm (0·50 m/sec) or 10% Rotor Speed - ± 1·5% Pitch Attitude - ± 1·5° Sideslip Angle - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	Steady descents Stability augmentation on/off		✓	✓	Two gross weight/CG combinations. At normal operating RPM. Rotor speed tolerance only applies if collective control position is fully down. Speed sweep from approximately 50 kt to at least maximum glide distance airspeed. May be a snapshot test.
i. Auto-rotational Entry	Torque - ± 3% Rotor speed - ± 3% Pitch Attitude - ± 2° Roll Attitude - ± 3° Heading - ± 5° Airspeed - ± 5 kt Altitude - ± 20ft (6·1m)	Cruise or climb		✓	✓	Time history of vehicle response to a rapid power reduction to idle. If cruise, data should be presented for the maximum range airspeed. If climb, data should be presented for the maximum rate of climb airspeed at or near maximum continuous power.

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

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL			COMMENTS
			1	2	3	
(1) Cyclic*	Breakout ± 0·25 lb (0·112 daN) or 25% Force ± 0·5 lb (0·224 daN) or 10%	Ground/Static Trim On/Off Friction Off Stability augmentation on/off	CT &M	✓	✓	Uninterrupted control sweeps. Does not apply to aircraft hardware modular controllers.
(2) Collective/Pedals *	Breakout ± 0·5 lb (0·224 daN) or 10% Force ± 1·0 lb (0·448 daN) or 10%	Ground/Static Trim on/off Friction off Stability augmentation on/off	CT &M	✓	✓	Uninterrupted control sweeps
(3) Brake Pedal Force vs. Position	± 5 lb (2·224 daN) or 10%	Ground/Static	CT &M	✓	✓	Simulator computer output results may be used to show compliance.
(4) Trim System Rate (all applicable axes)	Rate - ± 10%	Ground/Static Trim on Friction off	CT &M	✓	✓	Tolerance applies to recorded value of trim rate.
(5) Control Dynamics (all axes)	± 10% of time for first zero crossing and ± 10 (N+1)% of period thereafter ± 10% amplitude of first overshoot ± 20% of amplitude of 2nd and subsequent overshoots greater than 5% of initial displacement ± 1 overshoot	Hover/Cruise Trim on Friction off Stability augmentation on/off		CT &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. Refer to 3.4.1 below.
(6) Free play	± 0·10 in (2·5mm)	Ground/Static Friction off		✓	✓	Applies to all controls.

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

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL 1	LEVEL 2	LEVEL 3	COMMENTS
b. Low Airspeed Handling Qualities (1) Trimmed Flight Control Positions	Torque - ± 3% Pitch Attitude - ± 1·5° Bank Attitude - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	Translational Flight IGE. Sideward/ rearward/ forward Stability augmentation on/off		✓	✓	Several airspeed increments to translational airspeed limits and 45 kt forward. May be a snapshot test.
(2) Critical Azimuth	Torque - ± 3% Pitch Attitude - ± 1·5° Bank Attitude - ± 2° Longitudinal Control Position - ± 5% Lateral Control Position - ± 5% Directional Control Position - ± 5% Collective Control Position - ± 5%	Stationary Hover Stability augmentation on/off		✓	✓	Present data for three relative wind directions (including the most critical case) in the critical quadrant. May be a snapshot test.
(3) Control Response						
(i) Longitudinal	Pitch Rate - ± 10% or ± 2°/sec Pitch Attitude Change - ± 10% or ± 1·5°	Hover Stability augmentation on/off		CT &M	✓	Step control input. Off axis response must show correct trend for unaugmented cases.
(ii) Lateral	Roll Rate - ± 10% or ± 3°/sec Roll Attitude Change - ± 10% or ± 3°	Hover Stability augmentation on/off		CT &M	✓	Step control input. Off axis response must show correct trend for unaugmented cases.
(iii) Directional	Yaw Rate - ± 10% or ± 2°/sec Heading Change - ± 10% or ± 2°	Hover Stability augmentation on/off		CT &M	✓	Step control input. Off axis response must show correct trend for unaugmented cases.
(iv) Vertical	Normal Acceleration – ± 0·1g	Hover Stability augmentation on/off		CT &M	✓	Step control input. Off axis response must show correct trend for unaugmented cases.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL 1	LEVEL 2	LEVEL 3	COMMENTS
c. Longitudinal Handling Qualities						
(1) Control Response	Pitch Rate - ± 10% or ± 2°/sec Pitch Attitude Change – ± 10% or ± 1·5°	Cruise Stability augmentation on/off		CT &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 Autorotation Stability augmentation on/off	CT &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 1/2 or Double Amplitude or ± 0·02 of Damping Ratio	Cruise Stability augmentation on/off		CT &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 or ± 2°/sec Pitch Rate ± 0·1 g Normal Acceleration	Cruise or Climb Stability augmentation on/off		CT &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	LEVEL 1	LEVEL 2	LEVEL 3	COMMENTS
(4) Manoeuvring Stability	Longitudinal Control Position - ± 10% of change from trim or ± 0·25 in (6·3 mm) or Longitudinal Control Force - ± 0·5 lb (0·224 daN) or ± 10%	Cruise or Climb Stability augmentation on/off Left and right turns	CT &M	✓	✓	Force may be a cross plot for irreversible systems. Two airspeeds. May be a snapshot test. Approximately 30° and 45° bank attitude data should be presented.
(5) Landing Gear Operating Time	± 1 sec	Takeoff (Retraction) Approach (Extension)	CT &M	✓	✓	
d. Lateral and Directional Handling Qualities						
(1) Control Response						Two airspeeds to include one at or near the minimum power required speed.
(i) Lateral	Roll Rate - ± 10% or ± 3°/sec Roll Attitude Change - ± 10% or ± 3°	Cruise Stability augmentation on/off		CT &M	✓	Step control input. Off axis response must show correct trend for unaugmented cases.
(ii) Directional	Yaw Rate - ± 10% or ± 2°/sec Yaw Attitude Change - ± 10% or ± 2°	Cruise Stability augmentation on/off		CT &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	LEVEL 1	LEVEL 2	LEVEL 3	COMMENTS
(2) Directional Static Stability	Lateral Control Position - ± 10% of change from trim or ± 0·25in (6·3 mm) or Lateral Control Force - ± 0·5 lb (0·224 daN) or ± 10% Roll Attitude - ± 1·5° Directional Control Position - ± 10% of change from trim or ± 0·25 in (6·3 mm) or Directional Control Force - ± 1 lb (0·448 daN) or ± 10% Longitudinal Control Position - ± 10% of change from trim or ± ·25in (6·3mm)	Cruise or Climb/Descent Stability augmentation on/off	CT &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 sec or ± 10% of Period ± 10% of Time to ½ or Double Amplitude or ± ·02 of Damping Ratio ± 20% or ± 1 sec of Time Difference between peaks of Bank and Sideslip	Cruise or Climb Stability augmentation on/off	CT &M	CT &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, Bank - ±2° or ± 10% in 20 sec	Cruise or Climb Stability augmentation on/off	CT &M	CT &M	✓	Time history of release from pedal only or cyclic only turns in both directions. Terminate check at zero bank or unsafe attitude for divergent cases.
(iii) Adverse/Proverse Yaw	Correct trend, side slip - ±2°	Cruise or Climb Stability augmentation on/off		CT &M	✓	Time history of initial entry into cyclic only turns in both directions. Use moderate cyclic input rate.

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL			COMMENTS
			1	2	3	
3. ATMOSPHERIC MODELS						
(1) A test to demonstrate turbulence models.	None	Take-off, Cruise and Landing		✓	✓	
(2) Tests to demonstrate other atmospheric models to support the required training.					✓	
4. INTENTIONALLY LEFT BLANK						
5. VISUAL SYSTEM Note: refer to paragraph 3.3 of this subpart for additional visual tests.						
a. Visual Ground Segment (VGS)	± 20% of calculated VGS. Approach lights should be visible if they are in the visual segment (see example under Comments)	Static at 200 ft (61m) landing gear height above touchdown zone on glide slope, and 550m (1 805ft) RVR.		✓	✓	The QTG should indicate the source of data, i.e., ILS G/S antenna location, pilot eye reference point, cockpit cutoff angle, etc., used to make visual scene ground segment content calculations. Tolerance example: if the calculated VGS for the helicopter is 256m (840 ft), the 20% tolerance of 51 m (168 ft) may be applied at the near or far end of the VGS or may be split between both as long as the total of 168 ft is not exceeded.
b. Display System Tests						
(1) Visual System Colour	Demonstration model	Not Applicable		✓	✓	
(2) Visual Display Focus and intensity	Demonstration model	Not Applicable		✓	✓	
(3) Visual level horizon and Attitude vs. Attitude Indicator (Pitch and Roll Horizon)	Demonstration model	Not Applicable		✓	✓	

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL			COMMENTS
			1	2	3	
(4) Demonstrate 10 levels of occulting through each channel of the system	Demonstration model	Not Applicable		✓	✓	
(5) Daylight Scene Display Brightness of 17 cd/m^2 (5 foot-Lamberts) on the display measured at the design eye point.	Demonstration model	Not Applicable		✓	✓	
(6) Contrast Ratio 8:1	Demonstration model	Not Applicable		✓	✓	See para. 2.5.3 below
(7) Surface Resolution 3 arc minutes	Demonstration model	Not Applicable		✓	✓	See para. 2.5.3 below
(8) Light point Size - not greater than 6 arc minutes	Demonstration model	Not Applicable		✓	✓	
c. Visual Feature Recognition						
(1) Runway definition, Strobe Lights, Approach Lights, Edge White Lights, Visual Approach and Guidance Lights.	8 km minimum from the runway threshold	Approach		✓	✓	Within final picture resolution, the distances at which features are visible for tests (1) through (4) should not be less than those indicated in the specified test. Operators should indicate the light intensity level used for the test.
(2) Runway Centreline Lights or FATO/TLOF edge lights	5 km minimum from the runway threshold edge lights 5 km minimum from the FATO/TLOF edge lights	Approach		✓	✓	Same as c (1) above Approach angles up to 12 degrees should be covered
(3) Threshold Lights, Touchdown Zone Lights and Taxiway Definition Lights	3 km minimum from the runway threshold edge lights	Approach		✓	✓	Same as c (1) above
(4) Runway Markings, FATO/TLOF markings	Night/Dusk scenes within range of landing lights. Day scene as required by 3 arc minutes resolution.	Approach		✓	✓	
d. Visual Scene Content						

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL 1	LEVEL 2	LEVEL 3	COMMENTS
(1) Heliport Runways and Taxiways	Demonstration model	Ground/Flight		✓	✓	For Tests (1) through (10) the demonstration models can be a sampling of specific models used in the operator's training programme or a generic heliport model.
(2) Surfaces on runways and heliports	Demonstration model	Ground/Flight		✓	✓	
(3) Lighting for the landing area in use	Demonstration model	Ground/Flight		✓	✓	
(4) INTENTIONALLY LEFT BLANK						
(5) Day, dusk and night visual scene capability	Demonstration model	Flight		✓	✓	Dusk scene environment should include visible horizon and recognition of features on the surface.
(6) Generic surface characteristics	Demonstration model	Flight		✓	✓	Qualitative assessment
(7) Capability to present ground and air hazards such as another aircraft crossing the active runway or converging airborne traffic	Demonstration model	Ground/Flight		✓	✓	Qualitative assessment
(8) INTENTIONALLY LEFT BLANK						
(9) Realistic colour and directionality of airport/heliport lighting	Demonstration model	Ground/Flight		✓	✓	
(10) Freedom from apparent quantization (aliasing)	Demonstration model	Ground		✓	✓	
(11) INTENTIONALLY LEFT BLANK						
e. Weather Effects						
(1) INTENTIONALLY LEFT BLANK						
(2) INTENTIONALLY LEFT BLANK						

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL			COMMENTS
			1	2	3	
(3) Weather radar presentations in helicopters where radar information is presented on the pilot's navigation instruments. Radar returns should correlate with the visual scene.	Demonstration model	Flight			✓	Qualitative assessment
(4) Variable cloud base and visibility	Demonstration model	Approach		✓	✓	Weather effects described in tests (4) and (7) should be selectable via controls at the instructor station. Visibility and cloud effects should be checked at and below an altitude of 610 m (2 000 ft) height above the airport/heliport and within a radius of 16 km.
(5) INTENTIONALLY LEFT BLANK						
(6) INTENTIONALLY LEFT BLANK						
(7) Gradual break out	Demonstration model				✓	
f. Flight Compatibility INTENTIONALLY LEFT BLANK						
FTD SYSTEMS a. **Visual and cockpit Instrument Response** The test to determine compliance should include simultaneously recording the output from the pilot's cyclic, collective and pedals, 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 Authority.						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

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL 1	LEVEL 2	LEVEL 3	COMMENTS
						through the normal output interfaces 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.
(1) Visual and cockpit instrument response to an abrupt pilot controller input, compared to helicopter response for a similar input.	100 milliseconds or less after helicopter response OR	Climb, Cruise, Descent			✓	One test is required in each axis (pitch, roll. and yaw) for each of the 3 flight conditions, compared to helicopter data. (Totally 9 tests)
(2) Transport Delay	200 milliseconds or less after control movement.		✓			One test is required in each axis. (Pitch, Roll, Yaw).
	150 milliseconds or less after control movement.			✓		
	100 milliseconds or less after control movement				✓	
b. Sound						

TESTS	TOLERANCE	FLIGHT CONDITIONS	LEVEL 1	LEVEL 2	LEVEL 3	COMMENTS
(1) Realistic engine, transmission and rotor sounds			CT &M			
(2) Sound of precipitation, windshield wipers, and significant cockpit sounds which include engines, transmission, rotors and other aircraft systems during normal operation as well as the sound resulting from a blade strike and a crash when operating the helicopter in excess of limitations.	Not Applicable	Flight and Ground		CT &M	CT &M	Statement of Compliance or demonstration of representative sounds.
(3) INTENTIONALLY LEFT BLANK						
c. Diagnostic Testing (1) A means for quickly and effectively testing FTD programming and hardware. This could include an automated system, which could be used for conducting at least a portion of the tests in the QTG.			✓	✓	✓	
(2) INTENTIONALLY LEFT BLANK						

2.5 Information for Validation Tests

2.5.1 Control dynamics

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

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

(b) Recordings such as free response to a pulse or step function are classically used to estimate the dynamic properties of electromechanical systems. In any case, it is only possible to estimate the dynamic properties as a result of only being able to estimate true inputs and responses. Therefore, it is imperative that the best possible data be collected since close matching of the simulator control loading system to the helicopter systems is essential. The required control dynamics tests are indicated in paragraph 2.4.2.a.(5).

(c) For initial and upgrade evaluations, it is required that control dynamics characteristics be measured at and recorded directly from the cockpit controls. This procedure is usually accomplished by measuring the free response of the controls using a step input or pulse input to excite the system. The procedure should be accomplished in the takeoff, cruise, and landing flight conditions and configurations.

(d) For helicopters with irreversible control systems, measurements may be obtained on the ground if proper pitot-static inputs (if applicable) are provided to represent airspeeds typical of those encountered in flight. Likewise, it may be shown that for some helicopters, hover, climb, cruise and autorotation may have like effects. Thus, one may suffice for another. If either or both considerations apply, engineering validation or helicopter manufacturer rationale should be submitted as justification for ground tests or for eliminating a configuration. For FTD's requiring static and dynamic tests at the controls, special test fixtures will not be required during initial and upgrade evaluations if the STD operator's QTG shows both test fixture results and the results of an alternate approach, such as computer plots which were produced concurrently and show satisfactory agreement. Repeat of the alternate method during the initial evaluation would then satisfy this test requirement.

2.5.1.2 Control dynamics evaluation.

The dynamic properties of control systems are often stated in terms of frequency, Damping, and a number of other classical measurements which can be found in texts on control systems. In order to establish a consistent means of validating test results for simulator control loading, criteria are needed that will clearly define the interpretation of the measurements and the tolerances to be applied. Criteria are needed for both under-damped, and critically and over-damped systems. In the case of an under-damped system with very light damping, the system may be quantified in terms of frequency and damping. In critically damped or over-damped systems, the frequency and Damping are not readily measured from a response time history. Therefore, some other measurement should be used.

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

a. Under-damped response.

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

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

b. Critically damped and over-damped response

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

2.5.1.3 Tolerances

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

T(P0)	± 10% of P0
T(P1)	± 20% of P1
T(P2)	± 30% of P2
T(Pn)	± 10(n+1)% of Pn
T(An)	± 10% of A1, ± 20% of Subsequent Peaks
T(Ad)	± 5% of Ad = Residual Band
Overshoots	± 1

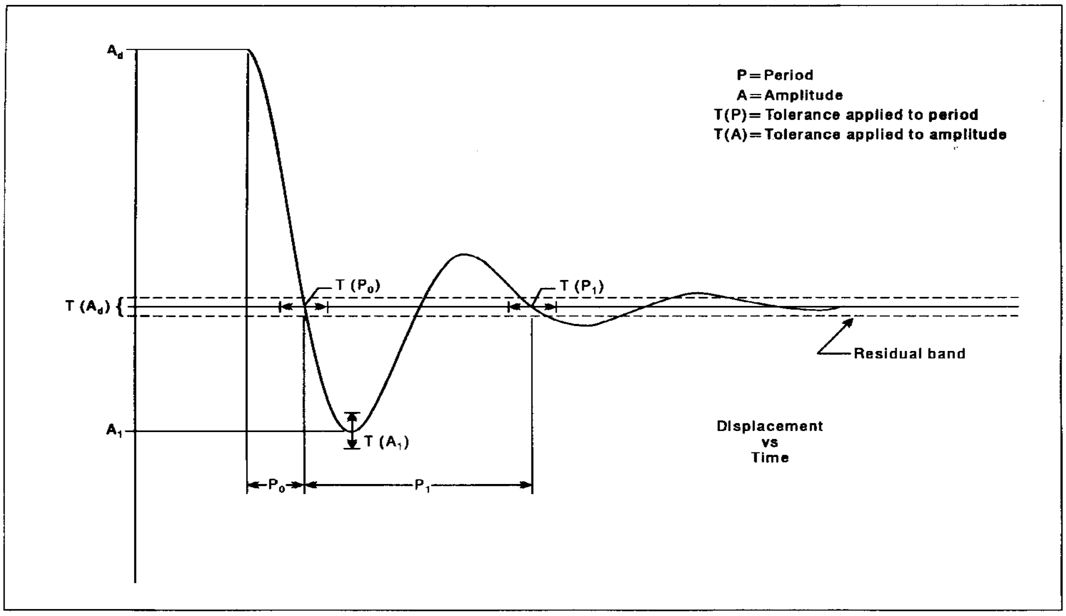


Figure 1 : Under-damped step response

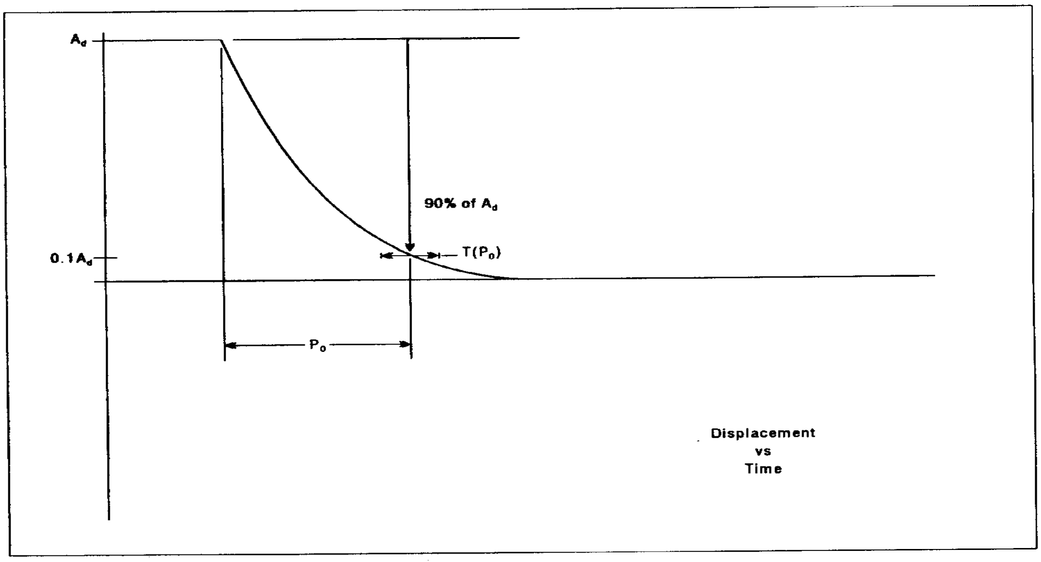


Figure 2: Critically damped step response

2.5.1.4 Alternate method for control dynamics

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

For each axis of pitch, roll, and yaw, the control should be moved to its normal limiting control positions (approximately 25-50% of full throw) for the following distinct rates. These tests should be conducted at typical taxi, takeoff, cruise, and landing conditions.

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

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

c. Fast dynamic test - Achieve a full sweep in approximately 4 seconds.

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

2.5.1.5 Tolerances

1. Static test - Items – See AC YCAR-STD 2H.030, paragraph 2.4 - 2.a (1), (2) and (3).

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

Note: The Authority is open to alternative means such as the one described above. Such alternatives should, however, be justified and appropriate to the application. For example, the method described here may not apply to all manufacturers' systems and certainly not to helicopters with Reversible Control Systems. Hence, each case should be considered on its own merit on an ad hoc basis. Should the Authority find that alternative methods do not result in satisfactory performance, then more conventionally accepted methods should be used

2.5.2 Ground Effect

2.5.2.1 For a FTD to be used for lift-off and touchdown it should faithfully reproduce the aerodynamic changes which occur in ground effect. The parameters chosen for FTD validation should obviously be indicative of these changes. The primary validation parameters for characteristics in ground effect are:

a. Longitudinal, lateral, directional and collective control positions

b. Torque required for hover

c. Height

d. Airspeed

e. Pitch Attitude

f. Roll Attitude

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

2.5.2.3 The allowable parameter tolerances for validation of ground effect characteristics are:

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

b. Torque required for hover ± 5%

c. Height ± 10% or ± 1·5M (5 ft)

d. Airspeed ± 3 Kts

e. Pitch Attitude ± 1º
f. Roll Attitude+-1º

2.5.3 Visual systems

Daylight visual systems should meet the following criteria:

a) Contrast Ratio. A raster drawn test pattern filling the entire visual scene (three or more channels) should consist of a matrix of black and white squares no larger than 10 degrees and no smaller than 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° spot photometer. This value should have a minimum brightness of 7 cd/m2 (2 foot-Lamberts). Measure any adjacent dark squares. The contrast ratio is the bright square value divided by the dark square value. Minimum test contrast ratio result is 8:1.

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

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

c) Resolution will be demonstrated by a test of objects shown to occupy a visual angle of 3 arc minutes in the visual scene measured at each pilot's eye position towards the middle of each channel. This should be confirmed by calculations in the Statement of Compliance.

d) Light point size. Light point size not greater than 6 arc minutes measured in a test pattern consisting of a single row of light points reduced in length until modulation is just discernible, a row of 40 lights will form a 4 degree angle or less.

e) Field of View. 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.

3. Functions and Subjective Tests

3.1 Discussion

3.1.1 Accurate replication of helicopter systems functions will be checked at each flight crew member position. This includes procedures using the STD operator's approved manuals, helicopter manufacturer's approved manuals and checklists. Handling qualities, performance, and simulator systems operation will be subjectively assessed. In order to assure the Functions Tests are conducted in an efficient and timely manner, operators are encouraged to co-ordinate with the appropriate Authority responsible for the evaluation so that any skills, experience or expertise needed by the Authority in charge of the evaluation team are available.

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

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

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

3.2 Test requirements

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

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

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

3.2.4 When evaluating functions and subjective tests, the fidelity of simulation required for the highest level of qualification should be very close to the aircraft. However, for the lower levels of qualification the degree of fidelity may be reduced in accordance with the criteria contained in paragraphs 2 and 3 above.

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.

3.3 Functions and subjective tests

It is accepted that tests will apply to FTD Level 1only if that system and flight condition is simulated.

It is intended that the tests listed below should be conducted in automatic flight. Where automatic flight is not possible and pilot manual handling is required, the FTD should be at least controllable to permit the conduct of the flight.

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FTD LEVEL		
	1	2	3
a. PREPARATION OF FLIGHT (1) Pre-Flight: Accomplish a functions check of all switches, indicators, systems and equipment at crew members and instructors stations and determine that the flight deck design and functions are identical to that of the helicopter within the scope of simulation.	✓	✓	✓
b. SURFACE OPERATIONS (PRE-TAKE-OFF) **(1) Engine start** (a) Normal start (b) Alternate start procedures (c) Abnormal starts and shutdowns (hot start, hung start, fire, etc) (d) Rotor start / engagement and acceleration	✓	✓	✓
c. HOVER			
(1) Lift-off			
(2) Hover		✓	✓
(3) Instrument response (a) Engine instruments (b) Flight instruments		✓	✓
(4) Hovering turns		✓	✓
(5) Hover power checks (a) In ground effect (IGE) (b) Out of ground effect (OGE)		✓	✓
(6) Crosswind/tailwind hover		✓	✓
(7) Antitorque effect		✓	✓
(8) Abnormal / emergency procedures: (a) Engine failures(s) (b) Fuel governing system failure (c) Hydraulic system failure (d) Stability system failure (e) Directional control malfunctions (f) Other		✓	✓
d. AIR TAXI / TRANSIT			
(1) Forward		✓	✓
(2) Sideways		✓	✓
(3) Rearward		✓	✓
e. TAKE-OFF			
(1) Cat. B or single engine helicopters (a) normal			

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FTD LEVEL		
	1	2	3
(i) From hover		✓	✓
(ii) Crosswind/tailwind		✓	✓
(iii) MTOM		✓	✓
(iv) Confined area			✓
(v) Slope			✓
(vi) Elevated heliport/helideck			✓
(b) abnormal / emergency procedures			
(i) Engine failure during take-off (If single engine, up to initiation of the flare)		✓[1]	✓
(ii) Forced landing (If single engine, up to initiation of the flare)		✓[1]	✓
(2) Cat A operation for all certified profiles			
(a) Take-off with engine failure			
(i) engine failure prior to TDP		✓[1]	✓
(ii) engine failure at or after TDP		✓[1]	✓
Note (1): Limited to clear area profile			
f. CLIMB			
(1) Cat. B or single engine helicopters			
(a) Clear area	✓	✓	✓
(b) Obstacle clearance		✓	✓
(c) Vertical		✓	✓
(d) Engine failure		✓	✓
(2) Cat. A Operation			
(a) With engine failure after V_y up to 300m (1 000ft) above the level of the heliport		✓	✓
g. CRUISE			
(1) Performance characteristics	✓	✓	✓
(2) Flying qualities (including turns at rate 1 and 2)		✓	✓
(3) Manoeuvres		✓	✓
(a) In-flight engine shutdown and restart			
(b) Manoeuvring with one or more engines inoperative (multi engines only)			
(c) Specific flight characteristics (e.g. vortex ring and retreating blade stall)			
(d) Flight control system failures			
(e) Other			

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FTD LEVEL		
	1	2	3
h. DESCENT **(1) Normal**	✓	✓	✓
(2) Auto-rotative	✓	✓	✓
i. VISUAL APPROACHES			
(1) **Cat.B or single engine helicopters**		✓	✓
(a) Approach (i) Normal (ii) Steep (iii) Shallow			
(b) Abnormal/emergency procedures: (i) One engine inoperative (ii) Fuel governing failure (iii) Hydraulics failure (iv) Stability system failure (v) Directional control failure (vi) Autorotation		✓	✓
(c) Balked landing (i) All engines operating (ii) One or more engines inoperative		✓	✓
(2) **Cat.A operation for all certified profiles** from 300m (1 000ft) above the level of the heliport to or after LDP		✓	✓
j. INSTRUMENT APPROACHES Only those instrument approach tests relevant to the simulated helicopter type should be selected from the following list.			
(1) Non-precision	✓	✓	✓
(a) All engine operating (b) One engine inoperative (c) Approach procedures: (i) NDB (ii) VOR/DME, RNAV (iii) ARA (Airborne radar approach) (iv) GPS			
(d) Missed approach (i) All engines and systems operating (ii) One engine inoperative (iii) Auto pilot failure			

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FTD LEVEL		
	1	2	3
(2) Precision	✓	✓	✓
(a) All engines operating			
(b) one engine inoperative			
(c) Approach procedures:			
(i) PAR			
(ii) DGPS			
(iii) ILS:			
Manual			
Flight director only			
Auto pilot coupled			
CAT I			
CAT II			
(d) Missed approach			
(i) All engine and systems operating			
(ii) One engine inoperative			
(iii) Auto pilot failure			
k. APPROACH TO LANDING / TOUCHDOWN			
(1) **Cat B or single engine helicopters**			
(a) Normal			
(i) Elevated heliport/heli-deck			✓
(ii) Confined area			✓
(iii) Slope			✓
(iv) Crosswind/tailwind			✓
(b) Abnormal/emergency procedures during approach to landing		✓[1]	✓
(i) One engine inoperative (multi-engine)			
(ii) Fuel governing failure			
(iii) Hydraulics failure			
(iv) Stability system failure			
(v) Directional control failure			
(vi) Autorotation (up to the initiation of the flare			
(c) Touchdown		✓[1]	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FTD LEVEL		
	1	2	3
(2) **Cat. A operation** (a) Landing with engine failure (i) engine failure prior to LDP (ii) engine failure at LDP Note (1): Limited to clear area profiles		✓[1]	✓
l. ANY FLIGHT PHASE			
(1) Helicopter and powerplant systems operation (a) Air conditioning (b) De-icing/anti-icing (c) Auxiliary powerplant (d) Communications (e) Electrical (f) Fire and smoke detection and suppression (g) Flight controls (primary and secondary) (h) Fuel and oil, hydraulic and pneumatic (i) Hydraulic (j) Landing gear (k) Oxygen (l) Power plant (including various failure modes) (m) Airborne radar (n) Autopilot and flight director (o) Collision avoidance systems (GPWS, ACAS, etc) (p) Flight control computers (q) Flight display systems (r) Flight management computers (s) Head-up guidance	✓	✓	✓
m. ENGINE SHUTDOWN AND PARKING			
(1) Engine and systems operation	✓	✓	✓
(2) Parking brake operation	✓	✓	✓
n. VISUAL SYSTEM			
(1) Accurate portrayal of environment relating to helicopter attitudes and position		✓	✓
(2) Operational helicopter lights		✓	✓
(3) Instructor controls on the following: (a) Cloud base/cloud tops (b) Visibility in kilometres/nautical miles and RVR in meters/feet (c) Airport/heliport (d) Airport/heliport lighting		✓	✓
(4) Visual system compatibility with aerodynamic programming		✓	✓
(5) Visual cues to assess sink rates, translational rates and height AGL during landings (e.g.) runways/heliports, taxiways, ramps and terrain features).		✓	✓
(6) Both night/dusk and day visual scene capability		✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FTD LEVEL		
	1	2	3
(7) Visual data base (a) At least three different heliport scenes which should be: (i) an area not less than 800m open surface level (ii) a surface level confined area and (iii) an elevated heliport (b) The content of the scenes should cover (i) Surfaces and markings on runways, heliport, taxiways and ramps (ii) Lighting of appropriate colour for all landing areas including runway edge, centreline, visual approach aids and approach lighting for the runway in use (iii) Helicopter perimeter and taxiway lighting (iv) Ramps and terminal buildings and vertical objects which correspond to the operational requirements of an operator's LOFT scenario.		✓	✓
(8) General terrain characteristics. Below 5 000ft present realistic visual scenes permitting navigation by sole reference to visual landmarks. Terrain contouring should be suitably represented where applicable		✓	✓
(9) At an below an altitude of 610m (2 000ft) height above the airport/heliport and within a radius of 16 kilometres (9 NM) from the airport/heliport, weather representations including the following: (a) Partial obscuration of ground scenes; the effect of a scattered to broken cloud deck (b) Gradual break out (c) The effect of fog on airport/heliport lighting.		✓	✓
(10) Operational visual scenes which provide a cue rich environment sufficient for low airspeed/low altitude manoeuvring and landing.		✓	✓
(11) Realistic colour and directionality of airport/heliport lighting.		✓	✓
(12) Weather radar presentations in helicopters where radar information is presented on the pilot's navigation instruments. Radar returns should correlate to the visual scene.		✓	✓
(13) Freedom from apparent quantisation (aliasing)		✓	✓
(14) To support LOFT, the visual system should provide smooth transition to new operational scenes without flight through clouds			✓
(15) The visual system should provide appropriate height and 3-D object collision detection feedback to support specific training needs.		✓	✓
o. SPECIAL EFFECTS			
(1) Significant helicopter noises should include engine, rotor and transmission to a comparable level found in a helicopter.	✓	✓	✓
(2) The sound of landing gear, other airframe sounds and a crash should be related to a logical manner to landing in an unusual attitude or in excess of structural limitations of the helicopter.		✓	✓

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FTD LEVEL		
	1	2	3
(3) Effects of icing, limited to performance (a) airframe (b) rotors		✓	✓

AC No. 2 to YCAR-STD 2H.030 (explanatory material)
Use of Data
See AC No. 1 to YCAR-STD 2H.030
See also AC No. 2 to YCAR-STD 2H.045

1. Two types of data are required for the development and qualification of an STD; namely, design data, which are used to develop simulation models, and the second, termed validation data, are used to objectively confirm that the simulation models reflect the static as well as the dynamic performance characteristics of the helicopter. Some levels of FTD to be qualified under YCAR-STD 2H require that their design data be based upon helicopter type specific data and/or that the validation tests have a similar baseline. It is not always intended that such design and validation data must be the helicopter manufacturers' flown test data in the same manner as are required for flight simulators. Whilst this is the preferred source, cost and availability can preclude their use. Acceptable alternatives can be data obtained from research laboratories or other data procurement agencies and companies as well as preliminary data from a helicopter manufacturer's engineering simulator.

2. For the FTD Level 1 & 2 much of the flight test data could be gathered from helicopter maintenance, performance, flight manuals, and system user guides supplemented by data gathered and recorded, in flight, by simple means, e.g. video, stopwatch, pencil & paper. However for the latter, comprehensive details of test methods and initial and ambient conditions should be presented. In addition, this data may also be supplemented with theoretically calculated results.

3. For FTD Level 3 it is necessary to use validation flight test data, such as is required for the flight simulator but limited only to the validation of flight, performance, handling qualities and systems characteristics.

4. The substitution of Correct Trend & Magnitude (CT&M) for defined tolerances also reduces the reliance upon specific flight test data, but this must not be taken as an indication that certain areas of simulation can be ignored. It is imperative that the specific characteristics of the helicopter are present and incorrect effects would be unacceptable.

5. The Authority will expect any FTD manufacturer who wishes to take advantage of the use of an alternative type of data to helicopter manufacturer's flown data, to demonstrate a sound engineering basis for his proposed approach. Such demonstration will need to show the predicted simulation effects and that they are easily understood and defined. The Authority will review any applications for the substitution of data other than that of the helicopter manufacturer's flown data.

AC No. 3 to YCAR-STD 2H.030 (explanatory material)
Guidance on Design and Evaluation
See YCAR-STD 2H.030

1 Design Standards

There are three sets of design standards specified within YCAR-STD 2H, FTD Levels 1, 2 and 3, the most demanding being those for FTD Level 3.

1.1 The Cockpit/Flight Deck. The cockpit should be representative of the “helicopter”. The controls, instruments and avionics controllers should be representative in touch, feel, layout, colour and lighting to create a positive learning environment and good transfer of training to the helicopter. For good training ambience the cockpit of the FTD I should be sufficiently enclosed to exclude any distractions. For both FTD Level 2 and 3 the cockpit should be fully enclosed. Distractions arising from external sources, which may affect the student’s concentration or that may denigrate the effects of the simulation, should be avoided. Thus in the case of an FTD Level1, if the rear of the device is open, it would be inappropriate to install this type of device in an non-enclosed room or in an area where several such devices are located. Where this is to be permitted, the activities in one device may affect those in an adjacent one. If the device is to be installed in an area shared by other devices then the rear of the cockpit/flight deck including the instructors’ station should be fully enclosed, and this enclosure should extend to include the roof. In the case of the FTD 2 and 3 the same interpretations should apply but an additional consideration is that the performance of the visual system will be adversely affected by any light ingress or reflections. It follows that it would not be necessary to have a fully enclosed structure at the rear of the cockpit/flight deck were the FTD to be installed in a separate room.

1.2 Cockpit/Flight Deck Components. As with any training device, the components used within the cockpit/flight deck area do not need to be helicopter parts: however, any parts used should be representative and should be robust enough to endure the training tasks. The use of CRTs or “Flat Panel” displays with physical overlays incorporating operational switches/knobs/buttons replicating a helicopter instrument panel would be acceptable. The training tasks envisaged for these devices are such that appropriate layout and feel is very important: i.e. the altimeter sub-scale knob needs to be physically located on the altimeter.

2 Latency and Visual

2.1 There are two methods of establishing latency which is the relationship between the controls and the visual system, cockpit/flight deck instruments response and initial motion system response, if fitted. These should be coupled closely to provide integrated sensory cues.

2.2 Either transport delay or response time tests are acceptable. Response time tests check that the response to abrupt pitch, roll, and yaw inputs at the pilot's position is within the permissible delay, but not before the time when the helicopter would respond under the same conditions. Visual scene changes from steady state disturbance should occur within the system dynamic response limit (but not before the resultant motion onset if fitted).

2.3 The transport delay test should measure all the delay encountered by a step signal migrating from the pilot's control through the control loading electronics (if applicable) and interfacing through all the simulation software modules in the correct order, using a handshaking protocol, finally through the normal output interfaces 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.

2.4 The Transport Delay of the system is the time between control input and the individual hardware responses. It need only be measured once in each axis.

3 Testing / Evaluation

3.1 To ensure that any device meets its design criteria initially and periodically throughout its life a system of objective and subjective testing will be used. The subjective testing may be similar to that in use in the recent past. The objective testing methodology is drawn from that used currently on flight simulators.

3.2 The validation tests specified under AC No. 1 to YCAR-STD 2H.030, para 2 can be "flown" by a suitably skilled person and the results recorded manually. Bearing in mind the cost implications, the use of automatic recording (and testing) is encouraged thereby increasing the repeatability of the achieved results.

3.3 The tolerances specified are designed to ensure that the device meets its original target criteria year after year. It is therefore important that any such target data is YCARefully derived and values are agreed with the Authority in advance of any formal qualification process.

3.4 The use of CT&M is not to be taken as an indication that certain areas of simulation can be ignored. For such tests, the performance of the device should be appropriate and representative of the helicopter configuration and should under no circumstances exhibit negative characteristics. 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 during recurrent evaluations.

3.5 The subjective tests listed under "Functions and Manoeuvres" in AC No. 1 to YCAR-STD 2H.030, para 3, should be flown out by a suitably qualified and experienced pilot.

Subjective testing will review not only the interaction of all of the systems but the integration of the FTD with:

a. Training environment

b. Freezes and repositions

c. Nav-aid environment

d. Communications

e. Weather and visual scene contents

In parallel with this objective/subjective testing process it is envisaged that suitable maintenance arrangements as part of a Quality Assurance Programme shall be in place. Such arrangements will cover routine maintenance, the provision of satisfactory spares holdings and personnel and may be subject to an regulatory audit.

4 Additional features

4.1 Any additional features in excess of the minimum design requirements added to any FTD Level 1, 2 and 3 will be subject to evaluation and should meet the appropriate standards in YCAR-STD 3H and 1H where appropriate.

AC No. 1 to YCAR-STD 2H.045 (explanatory material)
New Helicopter FTD Qualification
See YCAR-STD 2H.045
See also AC No.2 to YCAR-STD 2H.045

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

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

AC No. 2 to YCAR-STD 2H.045 (explanatory material)
New Helicopter FTD Qualification - Additional Information
See YCAR-STD 2H.045

1. In the case of new or derivative helicopters there will not usually be available helicopter manufacturer's approved final data for performance, handling qualities, systems, or avionics until well after the helicopter enters service. It is, of course, necessary in most cases to begin flight crew training and certification several months prior to the first entry of the helicopter into service in order to have qualified crew members in sufficient numbers at the time of the beginning of service with the new helicopter. Consequently, it will usually be preferable to use helicopter manufacturer provided preliminary data (performance, systems, avionics) for interim qualification of FTD.

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

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

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

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, 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.

6. The use of preliminary data is not indefinite. The helicopter manufacturer's final data should be available within six (6) months after helicopter first "service entry" or as agreed by the Authority, the STD operator and the helicopter manufacturer, but usually not later than one (1) year. In applying for an interim qualification, using preliminary data, the STD operator and the Authority should agree the update programme. This will normally specify that the final data update will be installed in the FTD within a period of six (6) months following the final data release unless special conditions exist and a different schedule agreed. The FTD 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 FTD programming and validation.

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

Note: The Proof of Match should meet the relevant AC YCAR-STD 2H.030 tolerances.

AC No. 3 to YCAR-STD 2H.045 (explanatory material)
Rotor Aerodynamic Modelling Techniques - Additional Information
See YCAR-STD 2H.045

1. Introduction

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

2. Disk models

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

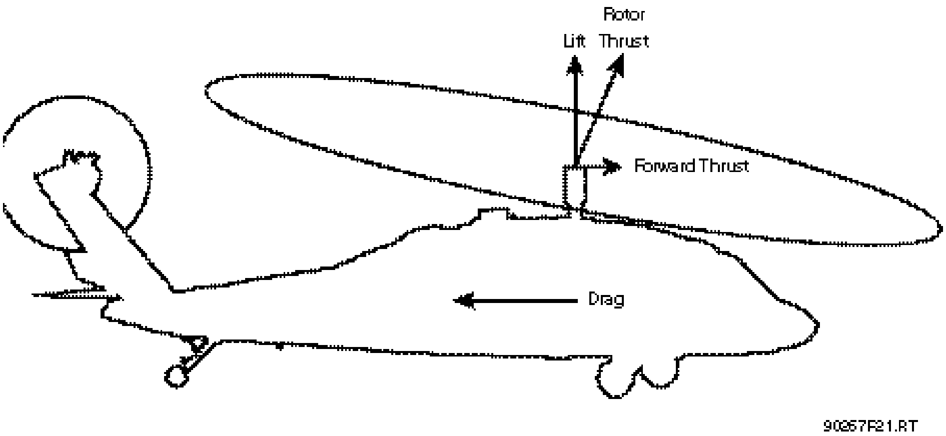


Figure1

3. Rotor map models

3.1 Rotor map models, or coefficient models, are also not computationally demanding. In this method a database of coefficients or stability and control derivatives is used to compute aircraft forces and moments. The simulation will interpolate its performance from the nearest points in the database. This database can be generated from flight test data analysis or from an off-line blade element model. Steady state performance can, in theory, be easily tuned by simply adjusting data points in the database. However if the database is generated from an off-line model blade element model then considerable effort could be spent tuning the off-line model that is one step removed from the simulation. The net result is a saving in real time execution, but development costs may be as high as a full blade element model.

The blade element model that generates the database, since it runs off-line, is not limited by real time constraints and thus can be considerably more complex than real time blade element models. Simulation fidelity may be limited by the overall size and coarseness of the database. Not every flight possibility will be covered by the database and separate databases may need to be generated to simulate failure modes. As with the rotor disk model, the incorporation of known air flows into the simulation at the blade elements is problematic and could effect, for example, the realism of simulated turbulence, and the effectiveness of confined area landing training where the winds have large gradients such that they will not be constant over the entire rotor disk.

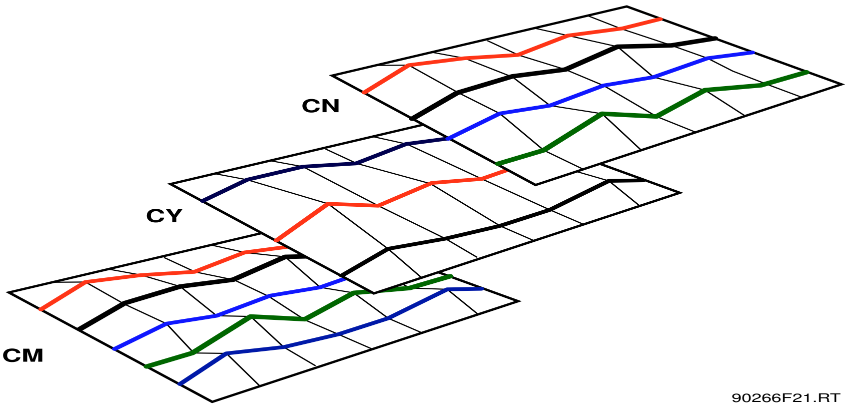


Figure 2

4. Blade Element Rotor Models

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

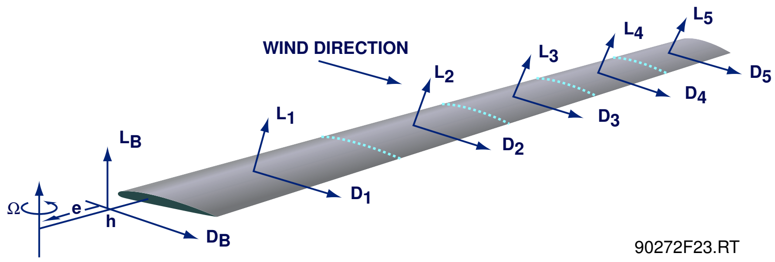


Figure 3

5. Conclusions

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