Doc 9625
AN/938

Manual of Criteria for the Qualification of Flight Simulation Training Devices

Volume II — Helicopters

Approved by the Secretary General
and published under his authority

First Edition — 2012

International Civil Aviation Organization

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AMENDMENTS

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AMENDMENTS		
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Foreword

This manual addresses the use of Flight Simulation Training Devices (FSTDs) representing aeroplanes (Volume I) and helicopters (Volume II). The methods, procedures and testing standards contained in Volume II of this manual are the result of the experience and expertise provided by National Aviation Authorities (NAA), experienced helicopter trainers, FSTD operators and manufacturers.

Development of Doc 9625

The first and second editions of the Doc 9625, initially developed in the late 1980s, were concerned with full flight simulators for aeroplanes only. There were no internationally accepted criteria for the design, qualification or operation of flight simulation devices for rotary wing aircraft.

At the Flight Simulation Conference of the Royal Aeronautical Society (RAeS) held in London in November 2005, the US Federal Aviation Administration (FAA) requested that the RAeS consider leading an international working group to review the technical criteria contained within the second edition of Doc 9625 and to expand these criteria to include all FSTDs for both aeroplanes and helicopters.

In response, the RAeS Flight Simulation Group established an International Working Group (IWG) in March 2006 to review the technical criteria contained within the second edition of this manual and to expand these accordingly. The IWG also decided that a fundamental review was necessary to establish the simulation fidelity levels required to support each of the required training tasks for each type of pilot licence, qualification, rating or training type. The goal of the working group was to develop a manual that, through ICAO, would form the basis of all national and international standards for a complete range of FSTDs.

The Aeroplane IWG (A-IWG) comprised members from the regulatory community, pilot representative bodies, the airlines, and the training and flight simulation industry and developed a unified set of technical criteria and training considerations, which were published as Volume I of the third edition of Doc 9625.

The Helicopter IWG (H-IWG) was composed of a similar cross-section of the industry, with wide representation from the regulatory community, helicopter manufacturers and operators, flight training organizations and the flight simulation industry. To enable the maximum coherence with Volume I, the H-IWG began its work approximately one year after the A-IWG and followed the same processes wherever possible.

Since the H-IWG did not have an equivalent template to the fixed-wing multi-crew pilot licence (MPL) with which to identify the key training tasks, a list of common training tasks was developed by the group and is included in Part I of Volume II. In order to keep the scale of the work manageable, most mission-specific tasks were excluded, as the extremely varied nature of civil helicopter operations meant that it was not practical to include them in the scope of this work. For the same reason, the scope of this work was limited to helicopters; tilt-rotor and other rotary wing aircraft were excluded. The resulting set of technical criteria and training considerations form the contents of this new Volume II of Doc 9625.

Acknowledgements

ICAO is grateful to the Royal Aeronautical Society and its International Working Group — Helicopters for their considerable contribution to the development of this manual for publication by ICAO.

Introductory Material

The manual comprises two Volumes, each containing three Parts as follows:

Volume I — Manual of Criteria for the Qualification of FSTDs — Aeroplanes

Part I	—	Training Task Derived Flight Simulation Requirements
Part II	—	Flight Simulation Training Device Criteria
Part III	—	Flight Simulation Feature and Fidelity Level Criteria

Volume II — Manual of Criteria for the Qualification of FSTDs — Helicopters

Part I	—	Training Task Derived Flight Simulation Requirements
Part II	—	Flight Simulation Training Device Criteria
Part III	—	Flight Simulation Feature and Fidelity Level Criteria

Some sections are common between Parts I, II and III and these are presented in Part II only.

The process used to define flight simulation requirements was to conduct an analysis identifying tasks to be accomplished for the training, testing and checking of tasks applicable to various licences and types of training. Figure 1 summarizes this process.

The process outcome defines the levels of fidelity of simulation features required to support the training tasks associated with existing pilot licensing, qualification, rating or training types, leading to the identification of five baseline types of FSTDs, which were derived from training needs. These baseline types have thus not been classified using a hierarchy of technical complexity and are summarized in Part I, Appendix B. The qualification criteria for these five types are provided in Part II.

Individual flight simulation feature and fidelity level criteria are provided in Part III and will provide the industry with criteria for the purposes of:

- international standardization of helicopter FSTD qualification;
- tailoring of existing helicopter FSTDs to meet existing or future training needs; and
- design of new helicopter FSTDs to meet existing or future training needs.

In summary:

Pilot licensing, qualification, rating or training type

The ten training types considered are from various NAA definitions and are described in Volume II, Part I, Chapter 4. They are based on common licence types but also include operator-specific training to take into account the importance of such training in the helicopter industry. A range of common helicopter malfunctions has also been developed to provide guidance material.

Training tasks

The training tasks were derived from generic helicopter manoeuvres. Mission related tasks (with a few key exceptions for offshore helicopter operations) were not included due to the limited resources of the H-IWG. Some of these may be analysed and the results incorporated in future revisions to Volume II.

Simulation features

Following the methodology used by the aeroplane IWG, twelve simulation features were defined to act as building blocks to describe any level of FSTD. Vibration was added as an additional feature for helicopter simulators, to take into account the importance of this cue to helicopter pilots.

Other relevant FSTD features such as Instructor Operating Station, Diagnostics, and Updates, are covered under a separate feature "Miscellaneous" and apply to all FSTDs; this feature is not included in the various matrices but is covered in Appendix A to Part II.

Fidelity levels

Four fidelity levels of simulation feature were identified:

- None or Not Applicable (N);
- Generic (G);
- Representative (R); and
- Specific (S).

These levels are explained in more detail in Volume II, Part I, Chapter 3 through Chapter 6.

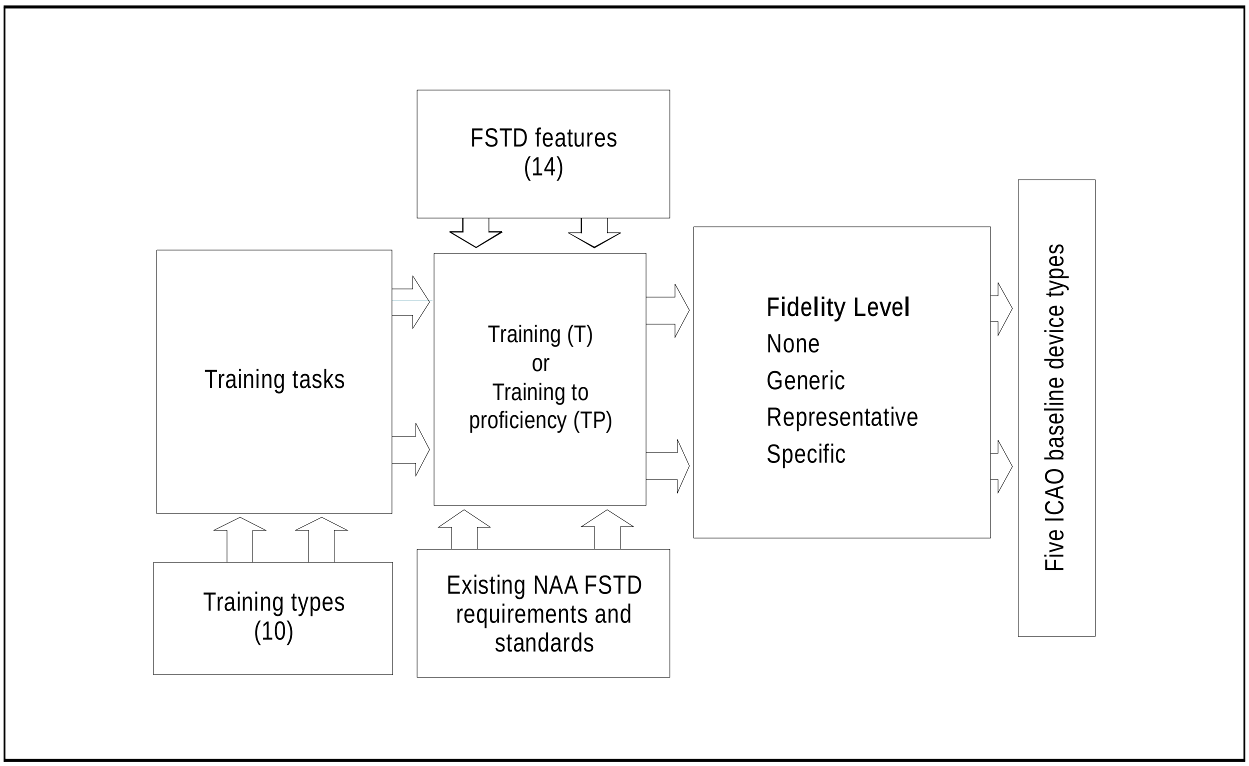

Figure 1. Training task analysis process

MANUAL OF CRITERIA FOR THE QUALIFICATION OF FLIGHT SIMULATION TRAINING DEVICES

Volume II
Helicopters

Part I
Training Task Derived Flight Simulation Requirements

Chapter 1

GLOSSARY OF TERMS AND ABBREVIATIONS

Refer to Part II, Chapter 1.

Chapter 2

VOLUME II CONTENT

2.1 Volume II provides guidance for the following:

- the process and methodology for FSTD qualification; and
- the training tasks that can be partly trained or trained to proficiency in a qualified FSTD.

2.2 There are three Parts to this Volume:

2.2.1 Part I — Training task derived flight simulation requirements

Part I contains an analysis of training tasks and related simulation feature and fidelity level requirements, including:

- a description of the tasks considered throughout a broad range of pilot licensing, qualification, rating and training requirements (see Appendix A and Chapter 4);
- a summary of five baseline FSTD examples (see Appendix B); and
- a reference to the training task matrix which compares each task, differentiated on the basis of licence or qualification requirements, against the suite of simulation features. Each simulation feature is defined at a "Specific", "Representative" or "Generic" level of fidelity or the feature is not required, i.e. "None" (see Appendix C).

2.2.2 Part II — Flight simulation training device criteria

Part II describes the FSTD general requirements, objective plus functions and subjective tests to qualify the five defined examples of FSTD referenced in the summary matrix in Part I, Appendix B.

2.2.3 Part III — Flight simulation feature and fidelity level criteria

Part III describes the general requirements, objective plus functions and subjective tests for the individual flight simulation features and fidelity levels to enable qualification of any FSTD.

Chapter 3

FSTD QUALIFICATION CRITERIA DETERMINATION PROCESS

3.1 Figure 3-1 provides a step-by-step process map to determine the fidelity levels and qualification criteria for the simulation features according to training task considerations. This enables the construction of a specific FSTD Qualification Test Guide (QTG).

3.1.1 Step 1 — Licence or Training Type. The sponsor identifies the intended use of the FSTD with reference to the pilot licence and qualification types listed in Chapter 4 and level of training or checking as defined in Chapter 8.

3.1.2 Step 2 — Determine the list of training tasks for licence or training type.

3.1.3 Decision. Confirm that the training tasks listed in Part I, Appendix A, for the licence or training type chosen fulfil the sponsor's and NAA requirements.

3.1.3.1 If the answer to this is yes (Y), then proceed to step 3(a) in 3.1.4.

3.1.3.2 If the answer to this is no (N), then proceed to step 3(b) in 3.1.5.

3.1.4 Step 3(a) — Referring to Part I, Appendix B: Determine the appropriate FSTD type example, then disregard step 3(b).

3.1.5 Step 3(b) — Referring to Part I, Appendix C: Determine the changes to the FSTD features/fidelity levels or training tasks, then go to step 4(b), in 3.1.8.

3.1.6 Decision. Does the FSTD under consideration meet the selected FSTD type example (I through V), referring to Part I, Appendix B?

3.1.6.1 If yes, go to step 4(a) in 3.1.7.

3.1.6.2 If no, go to 3(b) in 3.1.5.

3.1.7 Step 4(a) — Referring to Part II, Appendices A, B and C, determine the statements of compliance (SOCs) and testing requirements for the FSTD qualification.

3.1.8 Step 4(b) — Referring to Part III, Appendices A, B and C, determine the statements of compliance (SOCs) and testing requirements for the FSTD qualification.

3.1.9 Step 5 — Construct the Qualification Test Guide (QTG).

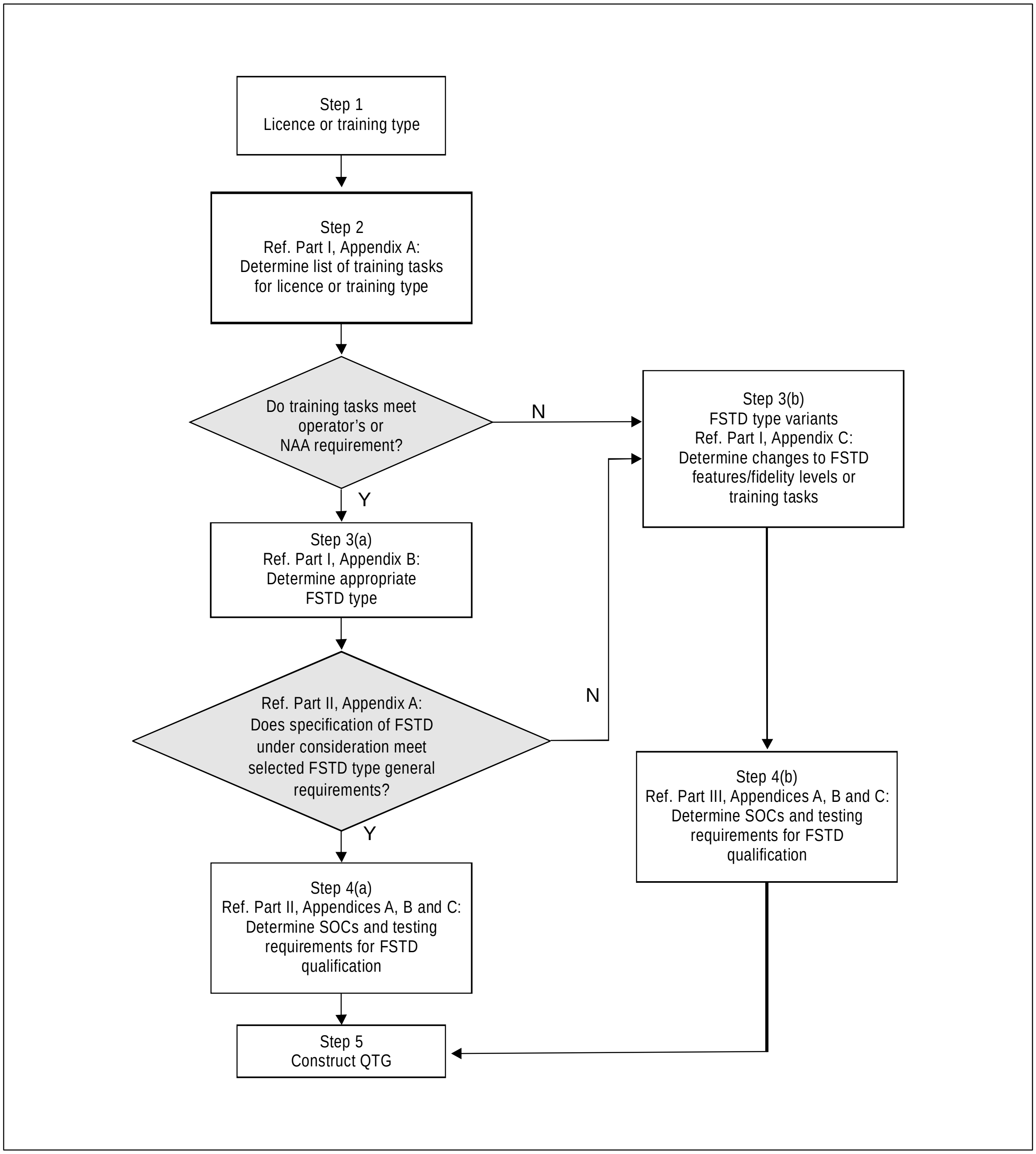

Figure 3-1. QTG specification process map

3.2 ADDITIONAL NOTES

3.2.1 As a future-proofing measure, an NAA may, within an accepted training programme offered at an approved training organization (ATO), authorize the use of an FSTD qualified under an alternative means of compliance from the device requirements established by Part I of this document.

3.2.2 A deviation from the criteria in Part II may be considered if the ATO demonstrates, to the satisfaction of the NAA, that the use of the FSTD achieves a training standard at least equivalent to that provided on a device traditionally used in a similar programme.

3.2.3 When it becomes apparent that a device type example from Part I, Appendix B, is not selected, the NAA should be consulted very early in the device definition process, and the overall process defined above should be followed.

3.2.4 If any of the device features differ from those of the five type examples in Part I Appendix B, then appropriate objective validation, functions and subjective tests will need to be defined using the information provided in Part III. These differences should be documented in the statement of qualification that also includes the authorized training or checking tasks sought and the contents of the authorized training programme. In this case the device should be referred to as an FSTD type I-V∆ (Delta), e.g. type IV∆.

———————

Chapter 4

LICENCE OR TYPE OF TRAINING

4.1 The ten pilot licensing, qualification, rating or training types identified that might utilize some level of FSTD were identified as follows from a review of existing regulatory material. Tasks were established from the list of eight licensing requirements and the two additional training types which are required but will vary according to aircraft type and operator requirements. The requirements were taken from FAA and JAA/EASA licensing regulations.

4.1.1 Traditional licence and rating types or training types from FAA and JAA/EASA regulations:

4.1.1.1 PPL — Private Pilot Licence;
4.1.1.2 CPL — Commercial Pilot Licence;
4.1.1.3 IR(I) —Instrument Rating (Initial);
4.1.1.4 IR(R) — Instrument Rating (Renewal);
4.1.1.5 ATPL — Airline Transport Pilot Licence or certificate;
4.1.1.6 TR(I) —Type Rating training and checking (Initial);
4.1.1.7 RL — Recurrent Licence (proficiency) training and checking; and
4.1.1.8 Re — Recency (take-off and landing).

4.1.2 Additional training types:

4.1.2.1 OS — Operator Specific training and checking; and
4.1.2.2 Mals — Malfunctions.

4.2 An additional training type, for which no training tasks list has been documented in this manual, is the multi-crew cooperation (MCC) training. Such training is required by some Licensing Authorities to develop the skills necessary for safe and efficient multi-crew operations, when transitioning from a single pilot environment. While no training tasks are specified, guidance on the requirements to qualify an FSTD for MCC training is contained in Attachment B — *Multi-crew cooperation training requirements* to this Part.

Chapter 5

TRAINING TASKS

5.1 The following definitions were used in the construction of the training matrix:

5.1.1 *Competency*. A combination of skills, knowledge and attitudes required to perform a task to the prescribed standard.

5.1.2 *Competency-based training and assessment*. Training and assessment that are characterized by a performance orientation, emphasis on standards of performance and their measurement, and the development of training to the specific performance standards.

5.1.3 *Competency element*. An action that constitutes a task that has a triggering event and a terminating event that clearly defines its limits, and an observable outcome.

5.1.4 *Competency unit*. A discrete function consisting of a number of competency elements.

The seven competency units that are required to be demonstrated are as follows:

5.1.4.1 Perform helicopter pre-flight and post-flight procedures.
5.1.4.2 Perform take-off and departure.
5.1.4.3 Perform in-flight operations.
5.1.4.4 Perform in-flight manoeuvres.
5.1.4.5 Perform instrument procedures.
5.1.4.6 Perform landings and approaches to landings.
5.1.4.7 React to malfunctions.

5.2 The training tasks considered include all those that are required to be trained or to be trained to proficiency for each of the training types or licences listed in Chapter 4. They are shown in detail in Appendix A.

5.3 Operator Specific tasks (OS) have been set up in order to provide guidance to commercial operators on what training tasks can typically be conducted using the five types of training device.

5.4 The list of malfunctions is representative of common malfunctions and is not meant to be prescriptive or to cover all eventualities. Paragraph 11 of Appendix C contains the list of malfunctions and contains the device feature fidelity levels required to perform typical malfunctions.

Chapter 6

FSTD SIMULATION FEATURES

6.1 To assist in the definition of the devices and to provide focus for the training analysis it was decided to breakdown any FSTD into the key components that would lead towards the construction of the FSTD specification. Consequently, thirteen FSTD features were defined from a training perspective which, used together and with an additional “Miscellaneous” feature, create an FSTD as follows:

6.1.1 Cockpit layout and structure. Defines the physical structure and layout of the cockpit environment, instrument layout and presentation, controls and seating for pilot, instructor, observer(s) and rear crew member (winch operator, winch man, medical staff, etc.).

6.1.2 Flight model (aero and engine). Defines the mathematical models and associated data to be used to describe the aerodynamic and flight dynamic characteristics required to be modelled in the FSTD.

6.1.3 Ground handling. Defines the mathematical models and associated data to be used to describe the ground handling characteristics and runway conditions required to be modelled in the FSTD whenever the helicopter is in contact with the surface (either wheeled or skidded helicopters).

6.1.4 Helicopter systems. Defines the types of helicopter systems simulation required to be modelled in the FSTD. The ATA chapter definitions describe these in more detail (e.g. hydraulic power, fuel, electrical power). Systems simulation will allow normal, abnormal and emergency procedures to be accomplished.

6.1.5 Flight controls and forces. Defines the mathematical models and associated data to be used to describe the flight controls and flight control force and dynamic characteristics required to be modelled in the FSTD.

6.1.6 Sound cue. Defines the type of sound cues required to be modelled. Such sound cues are those related to sounds generated externally to the cockpit environment such as sound of aerodynamics, engines, rotor noise (whine and blade slap) and weather effects, and those internal to the cockpit.

6.1.7 Visual display cue. Defines out-of-cockpit window image display field of view (horizontal and vertical) that is required to be seen by the pilots using the FSTD from their reference eyepoint. Technical requirements such as contrast ratio and light-point details are also described. NVG, HUD and EFVS options are also addressed. This is also referred to as visual cue.

6.1.8 Vibration cue. Defines the vibrations to be felt by the pilots during all phases of flight. These vibrations vary significantly depending on the flight parameter: hover IGE, hover OGE, hover into wind, downwind hover, hover taxi, transition to forward flight, translational lift, cruise, turns, steep turns, autorotation and so on.

6.1.9 Motion cue. Defines the type of motion cueing required that may be generated by the aircraft dynamics and from other effects such as airframe buffet, weather buffeting and ground taxiing.

6.1.10 Environment — Navigation. Defines the level of complexity of the simulated navigation aids, systems and networks with which the flight crew members are required to operate, such as GPS, VOR, DME, ILS or NDB.

6.1.11 Environment — Weather. Defines the level of complexity of the simulated ambient weather conditions, from temperature and pressure to full thunderstorm modelling, etc.

6.1.12 Environment — Landing areas and terrain. Defines the complexity and level of detail of the simulated landing areas and terrain modelling required. This includes such items as generic versus customized airports/heliports, visual scene requirements, terrain elevation, EGPWS databases, etc. Since helicopters can land at a variety of different types of landing areas, often outside aerodromes and/or controlled airspace, the environment should include these types of landing areas in their visual scenes modelling.

6.1.13 Environment — ATC. Defines the level of complexity of the simulated Air Traffic Control environment and how it interacts with the flight crew under training in the FSTD.

6.1.14 Miscellaneous. Defines FSTD criteria for the following miscellaneous features to support the above technical requirements, when appropriate:

- Instructor Operating Station (IOS);
- self-diagnostic testing;
- computer data storage capacity;
- record, freeze and playback capability;
- automated self-testing capability;
- the ability to update the FSTD's hardware and software;
- the ability to perform pre-flight systems checks; and
- the ability to measure system integration (transport delay).

Chapter 7

SIMULATION FEATURE FIDELITY LEVELS

7.1 Four fidelity levels, i.e. None, Generic, Representative and Specific, were used in the analysis in deciding for each training task the minimum fidelity level required for each simulation feature, except for the “Miscellaneous” feature. These can be grouped into three categories as follows:

7.1.1 *Aircraft simulation* comprising the following simulation features:

7.1.1.1 Cockpit layout and structure;
7.1.1.2 Flight model (aero and engine data);
7.1.1.3 Ground handling;
7.1.1.4 Helicopter systems; and
7.1.1.5 Flight controls and forces.

7.1.2 *Cueing simulation* comprising the following simulation features:

7.1.2.1 Sound cue;
7.1.2.2 Visual display cue;
7.1.2.3 Vibration cue; and
7.1.2.4 Motion cue.

7.1.3 *Environment simulation* comprising the following simulation features:

7.1.3.2 Environment — Navigation;
7.1.3.3 Environment — Weather;
7.1.3.4 Environment — Landing areas and terrain; and
7.1.3.1 Environment — ATC.

7.2 Fidelity levels for each feature category are described in Table 7-1.

Table 7-1. Fidelity levels for each feature category

Level	*Aircraft simulation*	*Cueing simulation*	*Environment simulation*
None	Not required.	Not required.	Not required.
Generic	Not specific to helicopter model, type or variant.	Generic to a helicopter of its group[1]. Simple modelling of key basic cueing features. For *visual cueing only*: Generic visual environment with perspective sufficient to support basic instrument flying and transition to visual from straight in instrument approaches.	Simple modelling of key basic environment features.
Representative	Representative of a helicopter of its group[1]. It does not have to be type-specific.	For *sound and motion cueing only*: Replicates the specific helicopter to the maximum extent possible. However physical limitations currently only provide representative, not specific, cues. For *vibration cueing only*: Representative of a helicopter of its group[1]. It does not have to be type-specific. For *visual cueing only*: Representative of the real world visual environment and perspective.	Representative of the real world environment.
Specific	Replicates the specific helicopter type.	For *sound and motion cueing only*: Not applicable. For *vibration cueing only*: Replicates the specific helicopter type. For *visual cueing only*: Replicates the real world visual environment and perspective.	Replicates the real world environment as far as possible for any specific location.

1. Refer to Part II, Chapter 1 for a definition of *group of helicopters*.

Chapter 8

TRAINING AND TRAINING-TO-PROFICIENCY

8.1 The “building block approach” to flight training recognizes the capability of accomplishing the procedural components of piloting tasks, including pilot manual handling tasks, in FSTDs without certain features (like motion) or reduced feature fidelity levels (like visual display). Using this approach, the training master matrix described in Appendix C to this Part assigns fidelity feature levels for each listed task where, as a minimum, training (T) is supported. Training is not completed until all tasks listed as training-to-proficiency (TP) are completed using the relevant TP device type.

8.2 Definitions of the terms *train* (T) and *train-to-proficiency* (TP) are in Part II, Chapter 1.

Chapter 9

REFERENCES AND RELATED READING MATERIAL

9.1 Applicants seeking FSTD evaluation, qualification and approval should consult references contained in related documents published by the International Civil Aviation Organization (ICAO), the International Air Transport Association (IATA) and the Royal Aeronautical Society (RAeS) referring to and/or dealing with the use of FSTDs and technical and operational requirements relevant to FSTD data and design. Applicable rules and regulations pertaining to the use of FSTDs in the State for which the FSTD qualification and approval is requested should also be consulted.

9.2 The related national and international documents which form the basis of the criteria set out in this manual are:

Australia
Civil Aviation Safety Regulations (CASR) Part 60, *Synthetic Training Devices;*
Civil Aviation Order 45.0;
FSD 1, *Operational Standards and Requirements, Approved Flight Simulators*; and
FSD 2, *Operational Standards and Requirements, Approved Flight Training Devices.*

Canada
TP9685, *Aeroplane and Rotorcraft Simulator Manual.*

France
Projet d'arrêté relatif à l'agrément des simulateurs de vol, 1988.

JAA
JAR-FSTD H, *Helicopter Flight Simulation Training Devices;*
JAR-FCL 2, *Flight Crew Licensing (Helicopter)*.

United States
14 CFR FAR Part 60, *Flight Simulation Training Device Initial and Continuing Qualification of Use;*
Advisory Circular 120-63, *Helicopter Simulator Qualification;* and
FAA, *Airline Transport Pilot and Aircraft Type Rating Practical Test Standards for Helicopter,* FAA-S-8081-20, US Government Printing Office, Washington, DC, August 1998.

9.3 Additional related documents are:

Royal Aeronautical Society:
Data Package Requirements for Design and Performance Evaluation of Rotary Wing Synthetic Training Devices. First Release, April 2004.

Note. —— For future reference, it should be noted that the RAeS has agreed in principle to produce a handbook for helicopters flight simulation training device evaluation, as an equivalent to the already existing aeroplane document.

9.4 It is important to regularly monitor regulatory guidance material on the NAA websites to understand the latest regulatory opinion on new technology or practices.

Appendix A

TRAINING TASK vs TRAINING/LICENCE TYPE MATRIX

1. INTRODUCTION

The matrix contained in this Appendix is derived from the Master Matrix and corresponds to Chapter 3, Figure 3-1, QTG specification process map, Step 2. It allocates the tasks considered appropriate for each of the licensing, qualification, rating or training types defined in Chapter 4 for which use of an appropriately qualified FSTD is suitable.

Some explanatory notes to aid understanding the matrix are as follows:

a) TP is conducted only in a helicopter for PPL and CPL;

b) Recency (Re) is only considered as a T exercise (and not TP); and

c) the malfunctions included in the Master Matrix cover generic helicopter malfunctions; the list of malfunctions is contained in Appendix C to this Part but is not an exhaustive list and is intended as a guide only (refer to Attachment A to this Part for complementary information). The malfunctions are not related to licence types and are therefore not included in this Appendix A.

2. Training task vs training/licence type matrix

Task Group	Number	Description	PPL	CPL	IR(I)	IR(R)	ATPL	TR(I)	RL	Re	OS
Pre- and post-flight procedures	**1.01**	Pre-flight inspection (cockpit only)	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	1.02	Pre-start checks, post-flight shutdown checks	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	1.03	Programme aircraft automation	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	1.04	Set up navigation aids	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	1.05	Engine(s) start/stop	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	1.06	Radio communications (voice)	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	1.07	Rotor start/stop	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	1.08	Systems check (elec, hyd, flt controls, autopilot)	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	1.09	Ground taxiing (if applicable)	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	1.10	Pre-take-off checks	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
Take-off and departure phase	**2.01**	Normal, crosswind and downwind take-off	T	T	N/A	N/A	T,TP	T,TP	T,TP	T	T,TP
	2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	T,TP
	2.03	Sloping ground take-off	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	2.04	Running take-off	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	2.05	Hover and post-take-off checks	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	2.06	Hover/air taxi	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	2.07	Sideways and rearwards flight	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	2.08	Spot turns	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	TP
	2.09	Turns around the tail	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	TP
	2.10	Transition into forward flight	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	N/A
	2.11	PC1/2/3 profile departures	N/A	T	N/A	N/A	T,TP	T,TP	T,TP	T	T,TP
	2.12	Reserved.									
	2.13	Confined area/helipad departure	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	2.14	Manage automation (mode select, autopilot)	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	2.15	Climb (VFR)	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	N/A
	2.16	Level-off (VFR)	T	T	N/A	N/A	T,TP	T,TP	N/A	N/A	N/A

Task Group	Number	Description	PPL	CPL	IR(I)	IR(R)	ATPL	TR(I)	RL	Re	OS
	2.17	Post-departure checks	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
In-flight operations	**3.01**	Comply with ATC instructions	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	3.02	Maintain visual separation	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	3.03	Radio communications (voice)	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	3.04	React to weather	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	3.05	Dead-reckoning	T	T	T,TP	T,TP	T,TP	N/A	N/A	N/A	N/A
	3.06	Visual navigation	T	T	N/A	N/A	T,TP	N/A	N/A	N/A	T,TP
	3.07	Radio navigation	N/A	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	3.08	Manage/react to EGPWS/ AVAD/TCAS/weather radar	N/A	N/A	T,TP	T,TP	N/A	T,TP	T,TP	N/A	T,TP
	3.09	Brief passengers	N/A	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
	3.10	Aircraft systems management	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
In-flight manoeuvres	**4.01**	Speed changes	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	4.02	Climbs and descents	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	4.03	Level turns	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	4.04	Steep turns (30 degrees or more bank angle)	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	4.05	Low speed flight	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	4.06	Autorotation descent (non-emergency)	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP
Instrument procedures	**5.01**	Instrument take-off	N/A	N/A	T,TP	T,TP	N/A	N/A	N/A	N/A	N/A
	5.02	SID	N/A	N/A	T,TP	T,TP	N/A	N/A	N/A	N/A	N/A
	5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	T	T	T,TP	T,TP	T,TP	N/A	N/A	N/A	N/A
	5.04	Standard terminal arrivals/FMS arrivals	N/A	N/A	T,TP	T,TP	N/A	N/A	N/A	N/A	T,TP
	5.05	Initial and final approach checks	N/A	N/A	T,TP	T,TP	N/A	T,TP	T,TP	N/A	T,TP
	5.06	Holding	N/A	N/A	T,TP	T,TP	N/A	N/A	N/A	T	N/A
	5.07	Precision approaches	N/A	N/A	T,TP	T,TP	N/A	N/A	N/A	T	N/A
	5.08	Non-precision instrument approaches	N/A	N/A	T,TP	T,TP	N/A	N/A	N/A	T	N/A
	5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	T,TP
	5.10	Missed approach/go-around	N/A	N/A	T,TP	T,TP	N/A	N/A	N/A	N/A	T,TP

Task Group	Number	Description	PPL	CPL	IR(I)	IR(R)	ATPL	TR(I)	RL	Re	OS
	5.11	Inadvertent entry into IMC	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	N/A
Landings and approaches to landings	**6.01**	Final approach/pre-landing checks	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	6.02	Confined area/elevated helipad approaches	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	6.03	Downwind approaches	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	N/A
	6.04	Quick stop	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	N/A
	6.05	Transitions to the hover	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	N/A
	6.06	PC1/2/3 normal and crosswind approaches	N/A	T	N/A	N/A	T,TP	T,TP	T,TP	T	T,TP
	6.07	Reserved.									
	6.08	Vertical landings	T	T	N/A	N/A	T,TP	T,TP	T,TP	T	T,TP
	6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	T,TP
	6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	T,TP
	6.11	Sloping ground landings	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	T,TP
	6.13	Running landings	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	6.14	Confined area/elevated helipad landings	T	T	N/A	N/A	T,TP	T,TP	T,TP	N/A	T,TP
	6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	T,TP
	6.16	Post-landing checks	T	T	T,TP	T,TP	T,TP	T,TP	T,TP	N/A	T,TP

Appendix B

FSTD SUMMARY MATRIX

1. SUMMARY MATRIX

For those operators that use the five FSTD baseline device types the summary matrix of Table B-1 applies.

Table B-1. FSTD Summary Matrix

Device type	Cockpit Layout and Structure	Flight Model (Aero and Engine)	Ground Handling	Helicopter Systems (ATA)	Flight Controls and Forces	Sound Cue	Visual Display Cue	Vibration Cue	Motion Cue	Environment – Navigation	Environment – Weather	Environment – Landing Areas and Terrain	Environment – ATC (Voice)
Type V	S	S	S	S	S	R	S	S	R	S	S	S	G
Type IV	S	S	S	S	S	R	S	S	R1	S	S	S	G
Type III	S	S	S	S	S	R	S	R	N	S	S	S	G
Type II (VFR)	R	R	G	R	R	G	S	G	N	S	R	R	G
Type I (IR)	R	R	G	R	R	G	G	G	N	S	G	G	G

Device type	**PPL**		**CPL**		**IR(I)**		**IR(R)**		**ATPL**		**TR(I)**		**RL**		**Re(90)**	**OS**		**MaIs**	
	TP	**T**	**TP**	**T**	**TP**	**T**	**TP**	**T**	**TP**	**T**	**TP**	**T**	**TP**	**T**	**T**	**TP**	**T**	**TP**	**T**
V	0%	100%	0%	100%	80%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
IV	0%	100%	0%	100%	80%	100%	100%	100%	66%	100%	65%	100%	65%	100%	0%	63%	100%	40%	100%
III	0%	100%	0%	100%	70%	100%	87%	100%	42%	100%	40%	100%	43%	100%	0%	43%	100%	24%	84%
II (VFR)	0%	92%	0%	87%	60%	93%	77%	93%	38%	87%	8%	19%	8%	45%	0%	4%	28%	0%	47%
I (IR)	0%	53%	0%	51%	60%	90%	77%	90%	32%	51%	8%	17%	8%	20%	0%	4%	15%	0%	40%

2. GUIDANCE FOR THE UNDERSTANDING OF THE FSTD SUMMARY MATRIX:

2.1 T — See guidance in Chapter 8 of this Part for *Train*.

2.2 TP — See guidance in Chapter 8 of this Part for *Train-to-Proficiency*.

2.3 A device which may be used to demonstrate proficiency (TP) may also be used to train (T) for the same task.

2.4 For definition of the derivative simulator feature fidelity level R1, refer to Part II, Chapter 2, paragraph 2.2.5.

2.5 For Environment — ATC the fidelity levels R and S in the summary matrix above are not currently used. The ATC environment simulation evaluation and the related qualification criteria will be subject to amendment based on experience and future proof of concept (see Attachment O to Part II).

2.6 The percentages mentioned in the above table are intended to act as a guide only. They are simply a numerical assessment of the proportion of tasks which can be completed for a particular licence or rating, which assumes that all tasks are of equal importance. Any training programme requires a more detailed syllabus, which is outside the scope of this Part, and only that syllabus, set against the Master Matrix, will give an assessment of the training which can be achieved with a particular device.

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Appendix C

FSTD MASTER MATRIX

1. INTRODUCTION

1.1 A Master Matrix was created which defines the device feature fidelity levels for each of the possible training tasks competencies for each of the ten “pilot licensing, qualification, rating or training types” described in Chapter 4 of this Part.

1.2 The Master Matrix was elaborated by experts in helicopter training and checking from regulators, operators and the training industry. It is contained in a spreadsheet with data evaluation, manipulation and filtering capabilities that were essential to the development of this manual. The output data of the Master Matrix spreadsheet have been summarized in this Appendix.

1.3 The Master Matrix consists of two tables:

- one table covering the training types for the “Training” requirement (T); and

- a second table covering the training types for the “Training-to-Proficiency” requirement (TP).

1.4 This is the basic reference material used to define the five FSTD baseline types and the material contained in Volume II, Part I.

1.5 The FSTD baseline types were reached by a process of rolling up the master matrix individual lines into a single line definition of a device that is able to cover a number of training tasks.

1.6 The following paragraphs (2 to 11) contain the printouts of the Master Matrix data for each individual training type of the ten types listed in Chapter 4 of this Part. Each training type printout of the Master Matrix data is subdivided into its “Training” requirement (T) and its “Training-to-Proficiency” requirement (TP), if these two requirements are both defined in the Master Matrix. Each paragraph shows the information available on the level of simulation fidelity required for each device feature and training type against the individual training task.

2. PPL — MASTER MATRIX DATA — TRAINING (T) — THE INTRODUCTION OF A SPECIFIC TRAINING TASK

PPL (T)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only)	R	N	N	R	G	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	G	G	G	G	G	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	G	N	N	G	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	G	N	N	G	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	G	G	G	G	G	N	N	N	N	N	G	N	N
1.06	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	G	G	G	G	G	N	G	G	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	G	G	G	G	R	G	G	G	N	N	G	N	N
1.09	Ground taxiing (if applicable)	G	G	G	G	G	N	R	G	N	N	G	G	N
1.10	Pre-take-off checks	G	G	G	G	G	N	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	G	G	G	R	R	N	R	G	N	N	G	R	N
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	G	G	R	R	R	N	R	G	N	N	G	R	N
2.04	Running take-off	G	G	R	R	R	N	G	G	N	N	G	G	N
2.05	Hover and post-take-off checks	G	R	N	R	G	N	R	N	N	N	G	R	N
2.06	Hover/air taxi	G	R	N	R	G	N	R	G	N	N	G	R	N
2.07	Sideways and rearwards flight	G	R	N	R	G	N	S	G	N	N	G	R	N
2.08	Spot turns	G	R	N	R	G	N	R	G	N	N	G	R	N
2.09	Turns around the tail	G	R	N	R	G	N	R	G	N	N	G	R	N
2.10	Transition into forward flight	G	R	N	R	G	N	R	G	N	N	G	R	N
2.11	PC1/2/3 profile departures	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.12	Reserved													
2.13	Confined area/helipad departure	G	G	N	R	R	N	S	G	N	N	G	R	N
2.14	Manage automation (mode select, autopilot)	R	R	N	R	R	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	G	R	N	G	G	N	G	G	N	N	G	G	N
2.16	Level-off (VFR)	G	R	N	G	G	N	G	G	N	N	G	G	N
2.17	Post-departure checks	G	G	N	G	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	G	G	N	G	G	G	G	N	N	S	G	G	G
3.02	Maintain visual separation	G	G	N	N	G	G	R	N	N	N	R	R	N
3.03	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
3.04	React to weather	G	G	N	G	G	G	R	N	N	N	R	G	N
3.05	Dead-reckoning	G	G	N	G	G	N	G	N	N	N	G	G	N
3.06	Visual navigation	G	G	N	G	G	N	R	N	N	N	G	R	N
3.07	Radio navigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.09	Brief passengers	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.10	Aircraft systems management	G	G	N	R	G	N	N	N	N	N	G	N	N
4.01	Speed changes	G	R	N	G	G	G	G	G	N	N	G	N	N
4.02	Climbs and descents	G	R	N	G	G	G	G	G	N	N	G	N	N
4.03	Level turns	G	R	N	G	G	G	G	G	N	N	G	N	N
4.04	Steep turns (30 degrees or more bank angle)	G	R	N	G	G	G	G	G	N	N	G	N	N
4.05	Low speed flight	G	R	N	G	G	G	G	G	N	N	G	N	N

PPL (T)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
4.06	Autorotation descent (non-emergency)	G	R	N	R	R	G	G	G	N	N	G	G	N
5.01	Instrument take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.02	SID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	G	R	N	G	G	G	N	G	N	N	G	N	N
5.04	Standard terminal arrivals/FMS arrivals	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.05	Initial and final approach checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.06	Holding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.07	Precision approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.08	Non-precision instrument approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.11	Inadvertent entry into IMC	G	G	N	G	G	N	R	N	N	N	G	R	N
6.01	Final approach/pre-landing checks	G	N	N	G	N	N	N	N	N	N	G	N	N
6.02	Confined area/ elevated helipad approaches	G	G	N	G	G	N	S	G	N	N	G	R	N
6.03	Downwind approaches	G	R	N	R	G	N	R	G	N	N	G	G	N
6.04	Quick stop	G	R	N	R	G	N	R	G	N	N	G	G	N
6.05	Transitions to the hover	G	R	N	R	G	N	R	G	N	N	G	R	N
6.06	PC1/2/3 normal and crosswind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.07	Reserved													
6.08	Vertical landings	G	G	G	R	R	N	R	G	N	N	G	R	N
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	G	G	R	R	R	N	R	G	N	N	G	R	N
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	G	G	R	R	R	N	G	G	N	N	G	G	N
6.14	Confined area/ elevated helipad landings	G	G	G	R	R	N	S	G	N	N	G	R	N
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	G	G	G	G	G	G	N	N	N	N	N	N	N

3. CPL — MASTER MATRIX DATA — TRAINING (T) — THE INTRODUCTION OF A SPECIFIC TRAINING TASK

CPL (T)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only).	R	N	N	R	G	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	G	G	G	G	G	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	G	N	N	G	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	G	N	N	G	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	G	G	G	G	G	N	N	N	N	N	G	N	N
1.06	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	G	G	G	G	G	N	G	G	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	G	G	G	G	R	G	G	G	N	N	G	N	N
1.09	Ground taxiing (if applicable)	G	G	G	G	G	N	R	G	N	N	G	G	N
1.10	Pre-take-off checks	G	G	G	G	G	N	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	G	G	G	R	R	N	R	G	N	N	G	R	N
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	G	G	R	R	R	N	R	G	N	N	G	R	N
2.04	Running take-off	G	G	R	R	R	N	G	G	N	N	G	G	N
2.05	Hover and post-take-off checks	G	R	N	R	G	N	R	N	N	N	G	R	N
2.06	Hover/air taxi	G	R	N	R	G	N	R	G	N	N	G	R	N
2.07	Sideways and rearwards flight	G	R	N	R	G	N	S	G	N	N	G	R	N
2.08	Spot turns	G	R	N	R	G	N	R	G	N	N	G	R	N
2.09	Turns around the tail	G	R	N	R	G	N	R	G	N	N	G	R	N
2.10	Transition into forward flight	G	R	N	R	G	N	R	G	N	N	G	R	N
2.11	PC1/2/3 profile departures	G	S	N	R	R	N	R	G	N	N	G	R	N
2.12	Reserved.													
2.13	Confined area/helipad departure	G	G	N	R	R	N	S	G	N	N	G	R	N
2.14	Manage automation (mode select, autopilot)	R	R	N	R	R	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	G	R	N	G	G	N	G	G	N	N	G	G	N
2.16	Level-off (VFR)	G	R	N	G	G	N	G	G	N	N	G	G	N
2.17	Post-departure checks	G	G	N	G	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	G	G	N	G	G	G	G	N	N	S	G	G	G
3.02	Maintain visual separation	G	G	N	N	G	G	R	N	N	N	R	R	N
3.03	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
3.04	React to weather	G	G	N	G	G	G	R	N	N	N	R	G	N
3.05	Dead-reckoning	G	G	N	G	G	N	G	N	N	N	G	G	N
3.06	Visual navigation	G	G	N	G	G	N	R	N	N	N	G	R	N
3.07	Radio navigation	G	G	N	G	G	N	N	N	N	S	G	G	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	G	G	N	R	G	N	N	N	N	N	G	N	N
4.01	Speed changes	G	R	N	G	G	G	G	G	N	N	G	N	N
4.02	Climbs and descents	G	R	N	G	G	G	G	G	N	N	G	N	N
4.03	Level turns	G	R	N	G	G	G	G	G	N	N	G	N	N
4.04	Steep turns (30 degrees or more bank angle)	G	R	N	G	G	G	G	G	N	N	G	N	N

CPL (T)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
4.05	Low speed flight	G	R	N	G	G	G	G	G	N	N	G	N	N
4.06	Autorotation descent (non-emergency)	G	R	N	S	S	G	G	G	N	N	G	G	N
5.01	Instrument take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.02	SID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	G	R	N	G	G	G	N	G	N	N	G	N	N
5.04	Standard terminal arrivals/FMS arrivals	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.05	Initial and final approach checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.06	Holding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.07	Precision approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.08	Non-precision instrument approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.11	Inadvertent entry into IMC	G	G	N	G	G	N	R	N	N	N	G	R	N
6.01	Final approach/pre-landing checks	G	N	N	G	N	N	N	N	N	N	G	N	N
6.02	Confined area/ elevated helipad approaches	G	G	N	G	G	N	S	G	N	N	G	R	N
6.03	Downwind approaches	G	R	N	R	G	N	R	G	N	N	G	G	N
6.04	Quick stop	G	R	N	R	G	N	R	G	N	N	G	G	N
6.05	Transitions to the hover	G	R	N	R	G	N	R	G	N	N	G	R	N
6.06	PC1/2/3 normal and crosswind approaches	G	S	N	R	R	N	R	G	N	N	G	R	N
6.07	Reserved.													
6.08	Vertical landings	G	G	G	R	R	N	R	G	N	N	G	R	N
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	G	G	R	R	R	N	R	G	N	N	G	R	N
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	G	G	R	R	R	N	G	G	N	N	G	G	N
6.14	Confined area/ elevated helipad landings	G	G	G	R	R	N	S	G	N	N	G	R	N
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	G	G	G	G	G	G	N	N	N	N	N	N	G

4. IR(I) — MASTER MATRIX DATA

4.1 IR(I) — Master Matrix Data — Training (T) —The introduction of a specific training task

IR(I) (T)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only)	G	N	N	G	G	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	G	N	G	G	G	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	G	N	N	G	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	G	N	N	G	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	G	G	G	G	G	N	N	N	N	N	G	N	N
1.06	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	G	G	G	G	G	N	N	N	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	G	G	G	R	G	N	N	N	N	N	G	N	N
1.09	Ground taxiing (if applicable)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.10	Pre-take-off checks	G	G	G	G	G	N	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.04	Running take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.05	Hover and post-take-off checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.06	Hover/air taxi	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.07	Sideways and rearwards flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.08	Spot turns	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.09	Turns around the tail	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.10	Transition into forward flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.11	PC1/2/3 profile departures	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.12	Reserved													
2.13	Confined area/helipad departure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.14	Manage automation (mode select, autopilot)	R	R	N	R	R	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.16	Level-off (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.17	Post-departure checks	G	G	N	G	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	G	G	N	G	G	N	N	N	N	S	G	N	G
3.02	Maintain visual separation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.03	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
3.04	React to weather	R	R	N	R	R	G	N	N	N	S	R	G	G
3.05	Dead-reckoning	N	N	N	N	N	N	N	N	N	N	N	G	N
3.06	Visual navigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.07	Radio navigation	G	G	N	G	G	N	N	N	N	S	G	N	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	S	S	N	S	R	N	N	N	N	N	R	S	G
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	R	R	N	R	G	N	N	N	N	N	G	N	N
4.01	Speed changes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.02	Climbs and descents	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.03	Level turns	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.04	Steep turns (30 degrees or more bank angle)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

IR(I) (T)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
4.05	Low speed flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.06	Autorotation descent (non-emergency)	R	S	N	S	S	G	N	N	N	N	G	G	N
5.01	Instrument take-off	G	R	N	G	R	N	G	N	N	S	G	G	G
5.02	SID	G	R	N	G	R	N	N	N	N	S	G	G	G
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	R	R	N	R	R	G	N	N	N	N	G	N	N
5.04	Standard terminal arrivals/FMS arrivals	G	G	N	G	G	N	N	N	N	S	G	G	N
5.05	Initial and final approach checks	G	G	N	G	G	N	N	N	N	S	G	G	N
5.06	Holding	G	G	N	G	G	N	N	N	N	S	G	G	N
5.07	Precision approaches	G	G	N	G	G	N	N	N	N	S	G	G	N
5.08	Non-precision instrument approaches	G	G	N	G	G	N	N	N	N	S	G	G	N
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	G	G	N	G	G	N	N	N	N	S	G	G	N
5.11	Inadvertent entry into IMC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.01	Final approach/pre-landing checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.02	Confined area/ elevated helipad approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.03	Downwind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.04	Quick stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.05	Transitions to the hover	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.06	PC1/2/3 normal and crosswind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.07	Reserved													
6.08	Vertical landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.14	Confined area/ elevated helipad landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	G	G	G	G	G	G	N	N	N	N	N	N	G

4.2 IR(I) — Master Matrix Data — Training-to-Proficiency (TP)

IR(I) (TP)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only)	R	N	N	G	G	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	G	N	G	G	G	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	R	N	N	R	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	G	N	N	G	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	G	G	G	G	G	G	N	N	N	N	G	N	G
1.06	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	G	G	G	G	G	G	N	N	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	R	G	G	R	G	N	N	N	N	N	G	N	N
1.09	Ground taxiing (if applicable)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.10	Pre-take-off checks	R	G	G	R	R	G	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.04	Running take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.05	Hover and post-take-off checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.06	Hover/air taxi	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.07	Sideways and rearwards flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.08	Spot turns	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.09	Turns around the tail	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.10	Transition into forward flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.11	PC1/2/3 profile departures	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.12	Reserved.													
2.13	Confined area/helipad departure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.14	Manage automation (mode select, autopilot)	S	S	N	S	S	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.16	Level-off (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.17	Post-departure checks	G	G	N	G	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	G	G	N	G	G	N	N	N	N	S	G	N	G
3.02	Maintain visual separation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.03	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
3.04	React to weather	S	R	N	S	R	G	N	N	N	S	R	G	G
3.05	Dead-reckoning	N	N	N	N	N	N	N	N	N	N	N	G	N
3.06	Visual navigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.07	Radio navigation	G	G	N	G	G	N	N	N	N	S	G	N	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	S	S	N	S	R	N	N	N	N	N	R	S	G
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	R	R	N	R	R	G	N	N	N	N	G	N	N
4.01	Speed changes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.02	Climbs and descents	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.03	Level turns	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.04	Steep turns (30 degrees or more bank angle)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.05	Low speed flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.06	Autorotation descent (non-emergency)	R	S	N	S	S	R	N	R	R1	N	G	G	N

IR(I) (TP)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
5.01	Instrument take-off	R	R	N	R	R	N	G	R	R1	S	G	G	G
5.02	SID	R	R	N	R	R	N	N	N	N	S	G	G	S
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	R	R	N	R	R	R	N	R	R1	N	G	N	N
5.04	Standard terminal arrivals/FMS arrivals	R	R	N	R	R	N	N	N	N	S	G	G	S
5.05	Initial and final approach checks	R	R	N	R	R	N	N	N	N	S	G	G	G
5.06	Holding	R	R	N	R	R	N	N	N	N	S	G	G	S
5.07	Precision approaches	R	R	N	R	R	N	N	N	N	S	G	G	S
5.08	Non-precision instrument approaches	R	R	N	R	R	N	N	N	N	S	G	G	S
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	R	R	N	R	R	N	N	G	R1	S	G	G	S
5.11	Inadvertent entry into IMC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.01	Final approach/pre-landing checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.02	Confined area/ elevated helipad approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.03	Downwind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.04	Quick stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.05	Transitions to the hover	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.06	PC1/2/3 normal and crosswind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.07	Reserved.													
6.08	Vertical landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.14	Confined area/ elevated helipad landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	R	G	G	R	R	G	N	N	N	N	N	N	G

5. IR(R) — MASTER MATRIX DATA

5.1 IR(R) — Master Matrix Data — Training (T) —The introduction of a specific training task

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
	IR(R) (T)													
1.01	Pre-flight inspection (cockpit only)	G	N	N	G	G	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	G	N	G	G	G	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	G	N	N	G	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	G	N	N	G	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	G	G	G	G	G	N	N	N	N	N	G	N	N
1.06	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	G	G	G	G	G	N	N	N	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	G	G	G	R	G	N	N	N	N	N	G	N	N
1.09	Ground taxiing (if applicable)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.10	Pre-take-off checks	G	G	G	G	G	N	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.04	Running take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.05	Hover and post-take-off checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.06	Hover/air taxi	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.07	Sideways and rearwards flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.08	Spot turns	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.09	Turns around the tail	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.10	Transition into forward flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.11	PC1/2/3 profile departures	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.12	Reserved													
2.13	Confined area/helipad departure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.14	Manage automation (mode select, autopilot)	R	R	N	R	R	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.16	Level-off (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.17	Post-departure checks	G	G	N	G	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	G	G	N	G	G	N	N	N	N	S	G	N	G
3.02	Maintain visual separation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.03	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
3.04	React to weather	R	R	N	R	R	G	N	N	N	S	R	G	G
3.05	Dead-reckoning	N	N	N	N	N	N	N	N	N	N	N	G	N
3.06	Visual navigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.07	Radio navigation	G	G	N	G	G	N	N	N	N	S	G	N	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	S	S	N	S	R	N	N	N	N	N	R	S	G
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	R	R	N	R	G	N	N	N	N	N	G	N	N
4.01	Speed changes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.02	Climbs and descents	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.03	Level turns	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.04	Steep turns (30 degrees or more bank angle)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

IR(R) (T)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
4.05	Low speed flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.06	Autorotation descent (non-emergency)	R	S	N	S	S	G	N	N	N	N	G	G	N
5.01	Instrument take-off	G	R	N	G	R	N	G	N	N	S	G	G	G
5.02	SID	G	R	N	G	R	N	N	N	N	S	G	G	G
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	R	R	N	R	R	G	N	N	N	N	G	N	N
5.04	Standard terminal arrivals/FMS arrivals	G	G	N	G	G	N	N	N	N	S	G	G	N
5.05	Initial and final approach checks	G	G	N	G	G	N	N	N	N	S	G	G	N
5.06	Holding	G	G	N	G	G	N	N	N	N	S	G	G	N
5.07	Precision approaches	G	G	N	G	G	N	N	N	N	S	G	G	N
5.08	Non-precision instrument approaches	G	G	N	G	G	N	N	N	N	S	G	G	N
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	G	G	N	G	G	N	N	N	N	S	G	G	N
5.11	Inadvertent entry into IMC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.01	Final approach/pre-landing checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.02	Confined area/ elevated helipad approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.03	Downwind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.04	Quick stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.05	Transitions to the hover	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.06	PC1/2/3 normal and crosswind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.07	Reserved.													
6.08	Vertical landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.14	Confined area/ elevated helipad landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	G	G	G	G	G	G	N	N	N	N	N	N	G

5.2 IR(R) — Master Matrix Data — Training-to-Proficiency (TP)

IR(R) (TP)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only)	G	N	N	G	G	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	G	N	G	G	G	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	R	N	N	R	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	G	N	N	G	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	G	G	G	G	G	G	N	N	N	N	G	N	G
1.06	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	G	G	G	G	G	G	N	N	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	R	G	G	R	G	N	N	N	N	N	G	N	N
1.09	Ground taxiing (if applicable)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.10	Pre-take-off checks	R	G	G	R	R	G	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.04	Running take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.05	Hover and post-take-off checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.06	Hover/air taxi	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.07	Sideways and rearwards flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.08	Spot turns	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.09	Turns around the tail	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.10	Transition into forward flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.11	PC1/2/3 profile departures	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.12	Reserved													
2.13	Confined area/helipad departure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.14	Manage automation (mode select, autopilot)	S	S	N	S	S	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.16	Level-off (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.17	Post-departure checks	G	G	N	G	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	R	R	N	R	R	N	N	N	N	S	G	N	G
3.02	Maintain visual separation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.03	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
3.04	React to weather	S	R	N	S	R	G	N	N	N	S	R	G	G
3.05	Dead-reckoning	N	N	N	N	N	N	N	N	N	N	N	G	N
3.06	Visual navigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.07	Radio navigation	G	G	N	G	G	N	N	N	N	S	G	N	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	S	S	N	S	R	N	N	N	N	N	R	S	G
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	R	R	N	R	R	G	N	N	N	N	G	N	N
4.01	Speed changes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.02	Climbs and descents	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.03	Level turns	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.04	Steep turns (30 degrees or more bank angle)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.05	Low speed flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.06	Autorotation descent (non-emergency)	R	S	N	S	S	R	N	R	R1	N	G	G	N

IR(R) (TP)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
5.01	Instrument take-off	R	R	N	R	R	N	G	R	R1	S	G	G	G
5.02	SID	R	R	N	R	R	N	N	N	N	S	G	G	G
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	R	R	N	R	R	R	N	R	R1	N	G	N	N
5.04	Standard terminal arrivals/FMS arrivals	R	R	N	R	R	N	N	N	N	S	G	G	G
5.05	Initial and final approach checks	R	R	N	R	R	N	N	N	N	S	G	G	G
5.06	Holding	R	R	N	R	R	N	N	N	N	S	G	G	G
5.07	Precision approaches	R	R	N	R	R	N	N	N	N	S	G	G	G
5.08	Non-precision instrument approaches	R	R	N	R	R	N	N	N	N	S	G	G	G
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	R	R	N	R	R	N	N	G	R1	S	G	G	G
5.11	Inadvertent entry into IMC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.01	Final approach/pre-landing checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.02	Confined area/ elevated helipad approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.03	Downwind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.04	Quick stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.05	Transitions to the hover	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.06	PC1/2/3 normal and crosswind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.07	Reserved													
6.08	Vertical landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.14	Confined area/ elevated helipad landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	R	G	G	R	R	G	N	N	N	N	N	N	G

6. ATPL — MASTER MATRIX DATA

6.1 ATPL — Master Matrix Data — Training (T) —The introduction of a specific training task

ATPL (T)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only)	R	N	N	R	G	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	G	G	G	G	G	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	G	N	N	G	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	G	N	N	G	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	G	G	G	G	G	N	N	N	N	N	G	N	N
1.06	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	G	G	G	G	G	N	G	N	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	G	G	G	G	R	G	G	N	N	N	G	N	N
1.09	Ground taxiing (if applicable)	G	G	G	G	G	N	R	G	N	N	G	G	N
1.10	Pre-take-off checks	G	G	G	G	G	N	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	G	G	G	R	R	N	R	N	N	N	G	G	N
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	G	G	R	R	R	N	R	N	N	N	G	R	N
2.04	Running take-off	G	G	R	R	R	N	G	N	N	N	G	G	N
2.05	Hover and post-take-off checks	G	R	N	R	G	N	R	N	N	N	G	G	N
2.06	Hover/air taxi	G	R	N	R	G	N	R	N	N	N	G	G	N
2.07	Sideways and rearwards flight	G	R	N	R	G	N	S	N	N	N	G	G	N
2.08	Spot turns	G	R	N	R	G	N	R	N	N	N	G	G	N
2.09	Turns around the tail	G	R	N	R	G	N	R	N	N	N	G	G	N
2.10	Transition into forward flight	G	R	N	R	G	N	R	N	N	N	G	G	N
2.11	PC1/2/3 profile departures	G	S	N	R	R	N	R	N	N	N	G	G	N
2.12	Reserved.													
2.13	Confined area/helipad departure	G	G	N	R	R	N	S	N	N	N	G	R	N
2.14	Manage automation (mode select, autopilot)	R	R	N	R	R	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	G	R	N	G	G	N	G	N	N	N	G	G	N
2.16	Level-off (VFR)	G	R	N	G	G	N	G	N	N	N	G	G	N
2.17	Post-departure checks	G	G	N	G	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	G	G	N	G	G	G	G	N	N	S	G	G	G
3.02	Maintain visual separation	G	G	N	N	G	G	R	N	N	N	R	R	N
3.03	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
3.04	React to weather	G	G	N	G	G	G	R	N	N	N	R	G	N
3.05	Dead-reckoning	G	G	N	G	G	N	G	N	N	N	G	G	N
3.06	Visual navigation	G	G	N	G	G	N	R	N	N	N	G	R	N
3.07	Radio navigation	G	G	N	G	G	N	N	N	N	S	G	G	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	G	G	N	R	G	N	N	N	N	N	G	N	N
4.01	Speed changes	G	R	N	G	G	G	G	N	N	N	G	N	N
4.02	Climbs and descents	G	R	N	G	G	G	G	N	N	N	G	N	N
4.03	Level turns	G	R	N	G	G	G	G	N	N	N	G	N	N
4.04	Steep turns (30 degrees or more bank angle)	G	R	N	G	G	G	G	N	N	N	G	N	N

ATPL (T)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
4.05	Low speed flight	G	R	N	G	G	G	G	N	N	N	G	N	N
4.06	Autorotation descent (non-emergency)	G	R	N	S	S	G	G	N	N	N	G	G	N
5.01	Instrument take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.02	SID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	G	R	N	G	G	G	N	N	N	N	G	N	N
5.04	Standard terminal arrivals/FMS arrivals	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.05	Initial and final approach checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.06	Holding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.07	Precision approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.08	Non-precision instrument approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.11	Inadvertent entry into IMC	G	G	N	G	G	N	R	N	N	N	G	R	N
6.01	Final approach/pre-landing checks	G	N	N	G	N	N	N	N	N	N	G	N	N
6.02	Confined area/ elevated helipad approaches	G	G	N	G	G	N	S	N	N	N	G	R	N
6.03	Downwind approaches	G	R	N	R	G	N	R	N	N	N	G	G	N
6.04	Quick stop	G	R	N	R	G	N	R	N	N	N	G	G	N
6.05	Transitions to the hover	G	R	N	R	G	N	R	N	N	N	G	G	N
6.06	PC1/2/3 normal and crosswind approaches	G	S	N	R	R	N	R	N	N	N	G	G	N
6.07	Reserved													
6.08	Vertical landings	G	G	G	R	R	N	R	N	N	N	G	G	N
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	G	G	R	R	R	N	R	N	N	N	G	R	N
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	G	G	R	R	R	N	G	N	N	N	G	G	N
6.14	Confined area/ elevated helipad landings	G	G	G	R	R	N	S	N	N	N	G	R	N
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	G	G	G	G	G	G	N	N	N	N	N	N	G

6.2 ATPL — Master Matrix Data — Training-to-Proficiency (TP)

ATPL (TP)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only)	R	N	N	R	G	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	R	G	G	R	R	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	R	N	N	R	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	G	N	N	G	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	G	G	G	G	G	G	N	N	N	N	G	N	G
1.06	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	G	G	G	G	G	G	R	R	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	G	G	G	R	R	G	G	G	N	N	G	N	N
1.09	Ground taxiing (if applicable)	G	G	G	G	G	G	R	G	R1	N	G	G	G
1.10	Pre-take-off checks	R	R	G	R	R	G	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	R	R	R	R	R	G	R	R	R	N	G	R	N
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	R	R	R	R	R	G	R	R	R	N	G	R	N
2.04	Running take-off	R	R	R	R	R	G	R	R	R1	N	G	R	N
2.05	Hover and post-take-off checks	R	R	N	R	R	G	R	R	R	N	G	R	N
2.06	Hover/air taxi	R	R	N	R	R	G	R	R	R	N	G	R	N
2.07	Sideways and rearwards flight	R	R	N	R	R	G	S	R	R	N	G	R	N
2.08	Spot turns	R	R	N	R	R	G	S	R	R	N	G	R	N
2.09	Turns around the tail	R	R	N	R	R	G	S	R	R	N	G	R	N
2.10	Transition into forward flight	R	R	N	R	R	G	R	R	R	N	G	R	N
2.11	PC1/2/3 profile departures	S	S	N	S	S	G	R	R	R	N	G	R	N
2.12	Reserved.													
2.13	Confined area/helipad departure	R	R	N	R	R	G	S	R	R	N	S	R	N
2.14	Manage automation (mode select, autopilot)	S	S	N	S	R	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	R	R	N	R	R	R	G	R	R1	N	G	G	N
2.16	Level-off (VFR)	R	R	N	R	R	R	G	R	R1	N	G	G	N
2.17	Post-departure checks	G	G	N	G	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	G	G	N	G	G	G	G	N	N	S	G	G	G
3.02	Maintain visual separation	G	G	N	N	G	G	R	N	N	N	R	R	N
3.03	Radio communications (voice)	G	N	N	G	N	N	N	N	N	N	N	N	G
3.04	React to weather	G	G	N	G	G	G	R	N	N	N	R	G	N
3.05	Dead-reckoning	G	G	N	G	G	N	G	N	N	N	G	G	N
3.06	Visual navigation	G	G	N	G	G	N	R	N	N	N	G	R	N
3.07	Radio navigation	G	G	N	G	G	N	N	N	N	S	G	G	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	G	G	N	R	G	G	N	N	N	N	G	N	N
4.01	Speed changes	R	R	N	R	R	R	G	G	R1	N	G	N	N
4.02	Climbs and descents	R	R	N	R	R	R	G	G	R1	N	G	N	N
4.03	Level turns	R	R	N	R	R	R	G	G	R1	N	G	N	N
4.04	Steep turns (30 degrees or more bank angle)	R	R	N	R	R	R	R	G	R1	N	G	N	N
4.05	Low speed flight	R	R	N	R	R	R	G	G	R1	N	G	N	N
4.06	Autorotation descent (non-emergency)	R	S	N	S	S	R	G	R	R1	N	G	G	N

ATPL (TP)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
5.01	Instrument take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.02	SID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	R	R	N	R	R	R	N	R	R1	N	G	N	N
5.04	Standard terminal arrivals/FMS arrivals	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.05	Initial and final approach checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.06	Holding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.07	Precision approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.08	Non-precision instrument approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.11	Inadvertent entry into IMC	G	G	N	G	G	N	R	N	R1	N	G	R	N
6.01	Final approach/pre-landing checks	G	N	N	G	N	N	N	N	N	N	G	N	N
6.02	Confined area/ elevated helipad approaches	R	R	N	R	R	G	S	R	R	N	G	R	N
6.03	Downwind approaches	R	R	N	R	R	G	R	R	R	N	G	G	N
6.04	Quick stop	R	R	N	R	R	G	R	R	R	N	G	G	N
6.05	Transitions to the hover	R	R	N	R	R	G	R	R	R	N	G	R	N
6.06	PC1/2/3 normal and crosswind approaches	S	S	N	S	S	G	R	R	R	N	G	R	N
6.07	Reserved.													
6.08	Vertical landings	R	R	R	R	R	G	R	R	R	N	G	R	N
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	R	R	R	R	R	G	R	R	R	N	G	R	N
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	R	R	R	R	R	G	R	R	R1	N	G	R	N
6.14	Confined area/ elevated helipad landings	R	R	R	R	R	G	S	R	R	N	S	R	N
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	R	R	G	R	R	G	N	N	N	N	N	N	G

7. TR(I) — MASTER MATRIX DATA

7.1 TR(I) — Master Matrix Data — Training (T) —The introduction of a specific training task

TR(I) (T)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only)	S	N	N	S	S	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	S	R	G	S	S	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	S	N	N	S	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	R	N	N	R	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	S	S	G	S	S	R	N	N	N	N	G	N	N
1.06	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	S	S	G	S	S	N	S	N	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	S	S	S	S	S	R	G	N	N	N	G	N	N
1.09	Ground taxiing (if applicable)	S	S	S	S	S	G	R	R	N	N	G	G	N
1.10	Pre-take-off checks	S	S	G	S	S	N	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	S	S	S	S	S	N	R	N	N	N	G	G	N
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	S	S	S	S	S	N	R	N	N	N	G	R	N
2.04	Running take-off	R	R	R	R	R	N	G	N	N	N	G	G	N
2.05	Hover and post-take-off checks	S	S	N	S	S	N	R	N	N	N	G	G	N
2.06	Hover/air taxi	S	S	N	S	S	N	R	N	N	N	G	G	N
2.07	Sideways and rearwards flight	S	S	N	S	S	N	S	N	N	N	G	G	N
2.08	Spot turns	S	S	N	S	S	N	S	N	N	N	G	G	N
2.09	Turns around the tail	S	S	N	S	S	N	S	N	N	N	G	G	N
2.10	Transition into forward flight	S	S	N	S	S	N	S	G	N	N	G	G	N
2.11	PC1/2/3 profile departures	G	S	N	R	R	N	R	N	N	N	G	G	N
2.12	Reserved													
2.13	Confined area/helipad departure	S	S	N	S	S	N	S	N	N	N	G	R	N
2.14	Manage automation (mode select, autopilot)	R	R	N	S	R	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	R	S	N	S	S	N	G	N	N	N	G	G	N
2.16	Level-off (VFR)	R	S	N	S	S	N	G	N	N	N	G	G	N
2.17	Post-departure checks	G	G	N	G	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	S	S	N	S	R	R	G	N	N	S	R	R	G
3.02	Maintain visual separation	S	S	N	S	R	R	S	N	N	N	R	R	N
3.03	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
3.04	React to weather	S	R	N	S	R	G	S	N	N	N	R	G	N
3.05	Dead-reckoning	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.06	Visual navigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.07	Radio navigation	S	S	N	S	R	N	N	N	N	S	G	N	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	S	S	N	S	R	N	N	N	N	N	R	S	G
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	S	S	N	S	S	N	N	N	N	N	G	N	N
4.01	Speed changes	R	R	N	R	R	G	G	N	N	N	G	N	N
4.02	Climbs and descents	R	R	N	R	R	G	G	N	N	N	G	N	N
4.03	Level turns	R	R	N	R	R	G	G	N	N	N	G	N	N
4.04	Steep turns (30 degrees or more bank angle)	R	R	N	R	R	G	G	N	N	N	G	N	N

TR(I) (T)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
4.05	Low speed flight	R	R	N	R	R	G	G	N	N	N	G	N	N
4.06	Autorotation descent (non-emergency)	R	S	N	S	S	G	G	N	N	N	G	G	N
5.01	Instrument take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.02	SID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.04	Standard terminal arrivals/FMS arrivals	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.05	Initial and final approach checks	S	S	N	S	S	N	N	N	N	S	G	G	N
5.06	Holding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.07	Precision approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.08	Non-precision instrument approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.11	Inadvertent entry into IMC	S	S	N	S	S	N	R	N	N	N	G	R	N
6.01	Final approach/pre-landing checks	G	N	N	G	N	N	N	N	N	N	G	N	N
6.02	Confined area/ elevated helipad approaches	G	G	N	G	G	N	S	N	N	N	G	R	N
6.03	Downwind approaches	S	S	N	S	S	N	S	N	N	N	G	G	N
6.04	Quick stop	S	S	N	S	S	N	S	N	N	N	G	G	N
6.05	Transitions to the hover	S	S	N	S	S	N	S	G	N	N	G	G	N
6.06	PC1/2/3 normal and crosswind approaches	G	S	N	R	R	N	R	N	N	N	G	G	N
6.07	Reserved													
6.08	Vertical landings	S	S	S	S	S	N	R	N	N	N	G	G	N
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	S	S	S	S	S	N	R	N	N	N	G	R	N
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	R	R	R	R	R	N	G	N	N	N	G	G	N
6.14	Confined area/ elevated helipad landings	S	S	S	S	S	N	S	N	N	N	G	R	N
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	S	S	G	S	S	G	N	N	N	N	N	N	G

7.2 TR(I)— Master Matrix Data — Training-to-Proficiency (TP)

TR(I)(TP)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only)	S	N	N	S	S	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	S	R	G	S	S	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	S	N	N	S	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	R	N	N	R	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	S	S	G	S	S	R	N	N	N	N	G	N	G
1.06	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	S	S	R	S	S	G	S	S	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	S	S	S	S	S	R	G	R	N	N	G	N	N
1.09	Ground taxiing (if applicable)	S	S	S	S	S	G	R	S	R1	N	G	G	G
1.10	Pre-take-off checks	S	S	G	S	S	G	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	S	S	S	S	S	R	S	S	R	N	G	R	N
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	S	S	S	S	S	R	S	S	R	N	G	R	N
2.04	Running take-off	S	S	S	S	S	R	R	S	R1	N	G	G	N
2.05	Hover and post-take-off checks	S	S	N	S	S	R	S	R	R	N	G	R	N
2.06	Hover/air taxi	S	S	N	S	S	R	S	S	R	N	G	R	N
2.07	Sideways and rearwards flight	S	S	N	S	S	R	S	S	R	N	G	R	N
2.08	Spot turns	S	S	N	S	S	R	S	S	R	N	G	R	N
2.09	Turns around the tail	S	S	N	S	S	R	S	S	R	N	G	R	N
2.10	Transition into forward flight	S	S	N	S	S	R	S	S	R	N	G	R	N
2.11	PC1/2/3 profile departures	S	S	N	S	S	R	S	S	R	N	G	R	N
2.12	Reserved													
2.13	Confined area/helipad departure	S	S	N	S	S	R	S	S	R	N	S	R	N
2.14	Manage automation (mode select, autopilot)	S	S	N	S	S	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	S	S	N	S	S	R	R	R	R1	N	G	G	N
2.16	Level-off (VFR)	S	S	N	S	S	R	R	R	R1	N	G	G	N
2.17	Post-departure checks	R	R	N	R	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	S	S	N	S	R	R	G	N	N	S	R	R	G
3.02	Maintain visual separation	S	S	N	S	R	R	S	N	N	N	R	R	N
3.03	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
3.04	React to weather	S	R	N	S	R	G	S	N	N	N	R	G	N
3.05	Dead-reckoning	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.06	Visual navigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.07	Radio navigation	S	S	N	S	R	N	N	N	N	S	G	N	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	S	S	N	S	R	N	N	N	N	N	R	S	G
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	S	S	N	S	S	R	N	N	N	N	G	N	N
4.01	Speed changes	S	S	N	R	S	R	G	S	R1	N	G	N	N
4.02	Climbs and descents	S	S	N	R	S	R	G	G	R1	N	G	N	N
4.03	Level turns	S	S	N	R	S	R	G	G	R1	N	G	N	N
4.04	Steep turns (30 degrees or more bank angle)	S	S	N	R	S	R	R	S	R1	N	G	N	N
4.05	Low speed flight	S	S	N	S	S	R	G	S	R1	N	G	N	N
4.06	Autorotation descent (non-emergency)	R	S	N	S	S	R	G	R	R1	N	G	G	N

TR(I)(TP)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
5.01	Instrument take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.02	SID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.04	Standard terminal arrivals/FMS arrivals	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.05	Initial and final approach checks	S	S	N	S	S	N	N	N	N	S	G	G	G
5.06	Holding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.07	Precision approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.08	Non-precision instrument approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.11	Inadvertent entry into IMC	S	S	N	S	S	N	R	N	R1	N	G	R	N
6.01	Final approach/pre-landing checks	R	N	N	R	N	N	N	N	N	N	G	N	N
6.02	Confined area/ elevated helipad approaches	S	S	N	S	S	R	S	S	R	N	G	R	N
6.03	Downwind approaches	S	S	N	S	S	R	S	S	R	N	G	R	N
6.04	Quick stop	S	S	N	S	S	R	S	S	R	N	G	R	N
6.05	Transitions to the hover	S	S	N	S	S	R	S	S	R	N	G	R	N
6.06	PC1/2/3 normal and crosswind approaches	S	S	N	S	S	R	S	S	R	N	G	R	N
6.07	Reserved													
6.08	Vertical landings	S	S	S	S	S	R	S	S	R	N	G	R	N
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	S	S	S	S	S	R	S	S	R	N	G	R	N
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	S	S	S	S	S	R	R	S	R1	N	G	G	N
6.14	Confined area/ elevated helipad landings	S	S	S	S	S	R	S	S	R	N	S	R	N
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	S	S	G	S	S	G	N	N	N	N	N	N	G

8. RL — MASTER MATRIX DATA

8.1 RL — Master Matrix Data — Training (T) —The introduction of a specific training task

RL (T)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only)	S	N	N	S	S	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	S	R	G	S	S	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	S	N	N	S	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	R	N	N	R	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	S	S	G	S	S	R	N	N	N	N	G	N	N
1.06	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	S	S	G	S	S	N	S	N	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	R	R	R	R	R	R	G	N	N	N	G	N	N
1.09	Ground taxiing (if applicable)	S	S	S	S	S	G	R	R	N	N	G	G	N
1.10	Pre-take-off checks	S	S	G	S	S	N	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	R	R	R	R	R	N	R	N	N	N	G	G	N
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	R	R	R	R	R	N	R	N	N	N	G	R	N
2.04	Running take-off	R	R	R	R	R	N	G	N	N	N	G	G	N
2.05	Hover and post-take-off checks	R	R	N	R	R	N	R	N	N	N	G	G	N
2.06	Hover/air taxi	R	R	N	R	R	N	R	N	N	N	G	G	N
2.07	Sideways and rearwards flight	R	R	N	R	R	N	S	N	N	N	G	G	N
2.08	Spot turns	R	R	N	R	R	N	R	N	N	N	G	G	N
2.09	Turns around the tail	R	R	N	R	R	N	R	N	N	N	G	G	N
2.10	Transition into forward flight	R	R	N	R	R	N	R	N	N	N	G	G	N
2.11	PC1/2/3 profile departures	R	R	N	R	R	N	R	N	N	N	G	G	N
2.12	Reserved													
2.13	Confined area/helipad departure	R	R	N	R	R	N	S	N	N	N	G	R	N
2.14	Manage automation (mode select, autopilot)	S	S	N	S	S	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	R	S	N	S	S	N	G	N	N	N	G	G	N
2.16	Level-off (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.17	Post-departure checks	G	G	N	G	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	S	S	N	S	R	R	G	N	N	S	R	R	G
3.02	Maintain visual separation	S	S	N	S	R	R	S	N	N	N	R	R	N
3.03	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
3.04	React to weather	S	R	N	S	R	G	S	N	N	N	R	G	N
3.05	Dead-reckoning	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.06	Visual navigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.07	Radio navigation	S	S	N	S	R	N	N	N	N	S	G	N	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	S	S	N	S	R	N	N	N	N	N	R	S	G
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	R	R	N	R	R	N	N	N	N	N	G	N	N
4.01	Speed changes	R	R	N	R	R	G	G	N	N	N	G	N	N
4.02	Climbs and descents	R	R	N	R	R	G	G	N	N	N	G	N	N
4.03	Level turns	R	R	N	R	R	G	G	N	N	N	G	N	N
4.04	Steep turns (30 degrees or more bank angle)	R	R	N	R	R	G	G	N	N	N	G	N	N

RL (T)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
4.05	Low speed flight	R	R	N	R	R	G	G	N	N	N	G	N	N
4.06	Autorotation descent (non-emergency)	R	S	N	S	S	G	G	N	N	N	G	G	N
5.01	Instrument take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.02	SID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.04	Standard terminal arrivals/FMS arrivals	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.05	Initial and final approach checks	S	S	N	S	S	N	N	N	N	S	G	G	N
5.06	Holding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.07	Precision approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.08	Non-precision instrument approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.11	Inadvertent entry into IMC	S	S	N	S	S	N	R	N	N	N	G	R	N
6.01	Final approach/pre-landing checks	G	N	N	G	N	N	N	N	N	N	G	N	N
6.02	Confined area/ elevated helipad approaches	R	R	N	R	R	N	S	N	N	N	G	R	N
6.03	Downwind approaches	R	R	N	R	R	N	R	N	N	N	G	G	N
6.04	Quick stop	R	R	N	R	R	N	R	N	N	N	G	G	N
6.05	Transitions to the hover	R	R	N	R	R	N	R	N	N	N	G	G	N
6.06	PC1/2/3 normal and crosswind approaches	R	R	N	R	R	N	R	N	N	N	G	G	N
6.07	Reserved													
6.08	Vertical landings	R	R	R	R	R	N	R	N	N	N	G	G	N
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	R	R	R	R	R	N	R	N	N	N	G	R	N
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	R	R	R	R	R	N	G	N	N	N	G	G	N
6.14	Confined area/ elevated helipad landings	R	R	R	R	R	N	S	N	N	N	G	R	N
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	S	S	G	S	S	G	N	N	N	N	N	N	G

8.2 RL— Master Matrix Data — Training-to-Proficiency (TP)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
	RL(TP)													
1.01	Pre-flight inspection (cockpit only)	S	N	N	S	S	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	S	R	G	S	S	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	S	N	N	S	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	R	N	N	R	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	S	S	G	S	S	R	N	N	N	N	G	N	G
1.06	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	S	S	R	S	S	G	S	R	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	R	R	R	R	R	R	G	R	N	N	G	N	N
1.09	Ground taxiing (if applicable)	S	S	S	S	S	G	R	R	R1	N	G	G	G
1.10	Pre-take-off checks	S	S	G	S	S	G	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	S	S	R	S	S	R	R	R	R	N	G	R	N
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	S	S	S	S	S	R	S	R	R	N	G	R	N
2.04	Running take-off	S	S	S	S	S	R	R	R	R1	N	G	G	N
2.05	Hover and post-take-off checks	S	S	N	S	S	R	R	R	R	N	G	R	N
2.06	Hover/air taxi	S	S	N	S	S	R	R	R	R	N	G	R	N
2.07	Sideways and rearwards flight	S	S	N	S	S	R	S	R	R	N	G	R	N
2.08	Spot turns	S	S	N	S	S	R	S	R	R	N	G	R	N
2.09	Turns around the tail	S	S	N	S	S	R	S	R	R	N	G	R	N
2.10	Transition into forward flight	S	S	N	S	S	R	S	R	R	N	G	R	N
2.11	PC1/2/3 profile departures	S	S	N	S	S	R	S	R	R	N	G	R	N
2.12	Reserved													
2.13	Confined area/helipad departure	S	S	N	S	S	R	S	R	R	N	S	R	N
2.14	Manage automation (mode select, autopilot)	S	S	N	S	S	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	S	S	N	S	S	R	R	R	R1	N	G	G	N
2.16	Level-off (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.17	Post-departure checks	G	G	N	G	N	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	S	S	N	S	R	R	G	N	N	S	R	R	G
3.02	Maintain visual separation	S	S	N	S	R	R	S	N	N	N	R	R	N
3.03	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
3.04	React to weather	S	R	N	S	R	G	S	N	N	N	R	G	N
3.05	Dead-reckoning	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.06	Visual navigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.07	Radio navigation	S	S	N	S	R	N	N	N	N	S	G	N	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	S	S	N	S	R	N	N	N	N	N	R	S	G
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	S	S	N	S	S	R	N	N	N	N	G	N	N
4.01	Speed changes	S	S	N	R	S	R	G	R	R1	N	G	N	N
4.02	Climbs and descents	S	S	N	R	S	R	G	G	R1	N	G	N	N
4.03	Level turns	S	S	N	R	S	R	G	G	R1	N	G	N	N
4.04	Steep turns (30 degrees or more bank angle)	S	S	N	R	S	R	R	G	R1	N	G	N	N
4.05	Low speed flight	S	S	N	S	S	R	G	R	R1	N	G	N	N

RL(TP)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
4.06	Autorotation descent (non-emergency)	R	S	N	S	S	R	G	R	R1	N	G	G	N
5.01	Instrument take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.02	SID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.04	Standard terminal arrivals/FMS arrivals	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.05	Initial and final approach checks	S	S	N	S	S	N	N	N	N	S	G	G	G
5.06	Holding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.07	Precision approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.08	Non-precision instrument approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.11	Inadvertent entry into IMC	S	S	N	S	S	N	R	N	R1	N	G	R	N
6.01	Final approach/pre-landing checks	G	N	N	G	N	N	N	N	N	N	G	N	N
6.02	Confined area/ elevated helipad approaches	S	S	N	S	S	R	S	R	R	N	G	R	N
6.03	Downwind approaches	S	S	N	S	S	R	S	R	R	N	G	R	N
6.04	Quick stop	S	S	N	S	S	R	S	R	R	N	G	R	N
6.05	Transitions to the hover	S	S	N	S	S	R	S	R	R	N	G	R	N
6.06	PC1/2/3 normal and crosswind approaches	S	S	N	S	S	R	S	R	R	N	G	R	N
6.07	Reserved													
6.08	Vertical landings	S	S	R	S	S	R	R	R	R	N	G	R	N
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	S	S	S	S	S	R	S	R	R	N	G	R	N
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	S	S	S	S	S	R	R	R	R1	N	G	G	N
6.14	Confined area/ elevated helipad landings	S	S	R	S	S	R	S	R	R	N	S	R	N
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	S	S	G	S	S	G	N	N	N	N	N	N	G

9. RE — MASTER MATRIX DATA — TRAINING (T)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
	Re (T)													
1.01	Pre-flight inspection (cockpit only)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.02	Pre-start checks, post-flight shutdown checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.03	Programme aircraft automation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.04	Set up navigation aids	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.05	Engine(s) start/stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.06	Radio communications (voice)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.07	Rotor start/stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.08	Systems check (elec, hyd, flt controls, autopilot)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.09	Ground taxiing (if applicable)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1.10	Pre-take-off checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.01	Normal, crosswind and downwind take-off	S	S	R	S	S	N	R	R	R	N	G	G	N
2.02	Take-off in snow, sand, dust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.03	Sloping ground take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.04	Running take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.05	Hover and post-take-off checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.06	Hover/air taxi	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.07	Sideways and rearwards flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.08	Spot turns	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.09	Turns around the tail	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.10	Transition into forward flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.11	PC1/2/3 profile departures	G	S	N	R	R	N	R	N	R	N	G	G	N
2.12	Reserved.													
2.13	Confined area/helipad departure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.14	Manage automation (mode select, autopilot)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.15	Climb (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.16	Level-off (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.17	Post-departure checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.01	Comply with ATC instructions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.02	Maintain visual separation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.03	Radio communications (voice)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.04	React to weather	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.05	Dead-reckoning	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.06	Visual navigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.07	Radio navigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.09	Brief passengers	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.10	Aircraft systems management	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.01	Speed changes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.02	Climbs and descents	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.03	Level turns	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.04	Steep turns (30 degrees or more bank angle)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.05	Low speed flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4.06	Autorotation descent (non-emergency)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Re (T)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
5.01	Instrument take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.02	SID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.04	Standard terminal arrivals/FMS arrivals	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.05	Initial and final approach checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.06	Holding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.07	Precision approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.08	Non-precision instrument approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.09	Conduct airborne radar approaches (ARA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.10	Missed approach/go-around	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.11	Inadvertent entry into IMC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.01	Final approach/pre-landing checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.02	Confined area/ elevated helipad approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.03	Downwind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.04	Quick stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.05	Transitions to the hover	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.06	PC1/2/3 normal and crosswind approaches	G	S	N	R	R	N	R	N	R	N	G	G	N
6.07	Reserved													
6.08	Vertical landings	S	S	R	S	S	N	R	R	R	N	G	G	N
6.09	Deck landings (ship)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.10	Rig landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.11	Sloping ground landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.12	Snow/sand/dust landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.13	Running landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.14	Confined area/ elevated helipad landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.15	Balked rig/deck landings	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.16	Post-landing checks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

10. OS — MASTER MATRIX DATA — TRAINING (T)

10.1 OS — Master Matrix Data — Training (T) — The introduction of a specific training task

OS (T)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only)	S	N	N	S	S	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	S	N	G	S	S	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	S	N	N	S	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	R	N	N	R	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	S	S	G	S	S	R	N	N	N	N	G	N	N
1.06	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	S	S	G	S	S	N	S	N	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	S	S	S	S	S	R	G	N	N	N	G	N	N
1.09	Ground taxiing (if applicable)	S	S	S	S	S	G	R	R	N	N	G	G	N
1.10	Pre-take-off checks	S	S	G	S	S	N	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	S	S	R	S	S	N	R	N	N	N	G	G	N
2.02	Take-off in snow, sand, dust	R	R	R	R	R	N	R	N	N	N	R	G	N
2.03	Sloping ground take-off	S	S	S	S	S	N	R	N	N	N	G	R	N
2.04	Running take-off	R	R	R	R	R	N	R	N	N	N	G	G	N
2.05	Hover and post-take-off checks	N	N	N	N	N	N	R	N	N	N	N	N	N
2.06	Hover/air taxi	N	N	N	N	N	N	R	N	N	N	N	N	N
2.07	Sideways and rearwards flight	N	N	N	N	N	N	S	N	N	N	N	N	N
2.08	Spot turns	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.09	Turns around the tail	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.10	Transition into forward flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.11	PC1/2/3 profile departures	R	S	N	S	R	N	R	N	N	N	G	G	N
2.12	Reserved.													
2.13	Confined area/helipad departure	G	G	N	R	R	N	S	N	N	N	R	R	N
2.14	Manage automation (mode select, autopilot)	R	R	N	S	R	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.16	Level-off (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.17	Post-departure checks	R	S	N	S	R	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	S	S	N	S	R	R	S	N	N	S	R	R	G
3.02	Maintain visual separation	S	S	N	S	R	R	S	N	N	N	R	R	N
3.03	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
3.04	React to weather	S	R	N	S	R	G	S	N	N	N	R	G	N
3.05	Dead-reckoning	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.06	Visual navigation	R	R	N	R	R	N	R	N	N	N	G	R	N
3.07	Radio navigation	S	S	N	S	R	N	N	N	N	S	G	N	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	S	S	N	S	R	N	N	N	N	N	R	S	G
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	S	S	N	S	S	N	N	N	N	N	G	N	N
4.01	Speed changes	G	R	N	G	G	G	G	N	N	N	G	N	N
4.02	Climbs and descents	G	R	N	G	G	G	G	N	N	N	G	N	N
4.03	Level turns	G	R	N	G	G	G	G	N	N	N	G	N	N
4.04	Steep turns (30 degrees or more bank angle)	G	R	N	G	G	G	G	N	N	N	G	N	N

OS (T)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
4.05	Low speed flight	R	R	N	R	R	G	G	N	N	N	G	N	N
4.06	Autorotation descent (non-emergency)	R	S	N	S	S	G	G	N	N	N	G	G	N
5.01	Instrument take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.02	SID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.04	Standard terminal arrivals/FMS arrivals	S	S	N	S	S	N	N	N	N	S	G	G	N
5.05	Initial and final approach checks	S	S	N	S	S	N	N	N	N	S	G	G	N
5.06	Holding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.07	Precision approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.08	Non-precision instrument approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.09	Conduct airborne radar approaches (ARA)	R	R	N	R	R	N	N	N	N	S	G	R	N
5.10	Missed approach/go-around	R	R	N	R	R	N	N	N	N	S	G	G	N
5.11	Inadvertent entry into IMC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.01	Final approach/pre-landing checks	R	S	N	S	R	N	N	N	N	N	G	N	N
6.02	Confined area/ elevated helipad approaches	R	S	N	S	R	N	S	N	N	N	G	R	N
6.03	Downwind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.04	Quick stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.05	Transitions to the hover	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.06	PC1/2/3 normal and crosswind approaches	R	S	N	S	R	N	R	N	N	N	G	G	N
6.07	Reserved													
6.08	Vertical landings	S	S	R	S	S	N	R	N	N	N	G	G	N
6.09	Deck landings (ship)	G	G	R	R	R	N	R	N	N	N	R	R	N
6.10	Rig landings	G	G	R	R	R	N	R	N	N	N	R	R	N
6.11	Sloping ground landings	S	S	S	S	S	N	R	N	N	N	G	R	N
6.12	Snow/sand/dust landings	R	R	R	R	R	N	R	N	N	N	R	G	N
6.13	Running landings	R	R	R	R	R	N	R	N	N	N	G	G	N
6.14	Confined area/ elevated helipad landings	G	G	R	R	R	N	S	N	N	N	R	R	N
6.15	Balked rig/deck landings	G	G	N	R	R	N	R	N	N	N	R	R	N
6.16	Post-landing checks	S	S	G	S	S	G	N	N	N	N	N	N	G

10.2 OS— Master Matrix Data — Training-to-Proficiency (TP)

OS(TP)														
Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
1.01	Pre-flight inspection (cockpit only)	S	N	N	S	S	N	N	N	N	N	N	N	N
1.02	Pre-start checks, post-flight shutdown checks	S	N	G	S	S	N	N	N	N	N	N	N	N
1.03	Programme aircraft automation	S	N	N	S	N	N	N	N	N	N	N	N	N
1.04	Set up navigation aids	R	N	N	R	N	N	N	N	N	S	N	N	N
1.05	Engine(s) start/stop	S	S	G	S	S	R	N	N	N	N	G	N	G
1.06	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
1.07	Rotor start/stop	S	S	R	S	S	G	S	S	N	N	G	N	N
1.08	Systems check (elec, hyd, flt controls, autopilot)	S	S	S	S	S	R	G	R	N	N	G	N	N
1.09	Ground taxiing (if applicable)	S	S	S	S	S	G	R	S	R1	N	G	G	G
1.10	Pre-take-off checks	S	S	G	S	S	G	N	N	N	S	N	N	G
2.01	Normal, crosswind and downwind take-off	S	S	R	S	S	R	S	R	R	N	G	R	N
2.02	Take-off in snow, sand, dust	S	S	R	S	S	R	S	R	R	N	R	R	N
2.03	Sloping ground take-off	S	S	S	S	S	R	S	R	R	N	G	R	N
2.04	Running take-off	S	S	S	S	S	R	S	R	R1	N	G	G	N
2.05	Hover and post-take-off checks	S	S	N	S	S	R	S	R	R	N	G	R	N
2.06	Hover/air taxi	S	S	N	S	S	R	S	R	R	N	G	R	N
2.07	Sideways and rearwards flight	S	S	N	S	S	R	S	R	R	N	G	R	N
2.08	Spot turns	S	S	N	S	S	R	S	R	R	N	G	R	N
2.09	Turns around the tail	S	S	N	S	S	R	S	R	R	N	G	R	N
2.10	Transition into forward flight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.11	PC1/2/3 profile departures	S	S	N	S	S	R	S	R	R	N	G	R	N
2.12	Reserved.													
2.13	Confined area/helipad departure	S	S	N	S	S	R	S	R	R	N	S	R	N
2.14	Manage automation (mode select, autopilot)	S	S	N	S	S	N	N	N	N	S	G	N	N
2.15	Climb (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.16	Level-off (VFR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.17	Post-departure checks	S	S	N	S	S	N	N	N	N	S	G	N	N
3.01	Comply with ATC instructions	S	S	N	S	R	R	S	N	N	S	R	R	G
3.02	Maintain visual separation	S	S	N	S	R	R	S	N	N	N	R	R	N
3.03	Radio communications (voice)	S	N	N	S	N	N	N	N	N	N	N	N	G
3.04	React to weather	S	R	N	S	R	G	S	N	N	N	R	G	N
3.05	Dead-reckoning	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.06	Visual navigation	S	S	N	S	S	N	S	N	N	N	G	R	N
3.07	Radio navigation	S	S	N	S	R	N	N	N	N	S	G	N	G
3.08	Manage/react to EGPWS/AVAD/TCAS/weather radar	S	S	N	S	R	N	N	N	N	N	R	S	G
3.09	Brief passengers	G	N	N	G	N	N	N	N	N	N	N	N	N
3.10	Aircraft systems management	S	S	N	S	S	R	N	N	N	N	G	N	N
4.01	Speed changes	R	R	N	R	R	R	G	R	R1	N	G	N	N
4.02	Climbs and descents	R	R	N	R	R	R	G	G	R1	N	G	N	N
4.03	Level turns	R	R	N	R	R	R	G	G	R1	N	G	N	N
4.04	Steep turns (30 degrees or more bank angle)	R	R	N	R	R	R	G	R	R1	N	G	N	N
4.05	Low speed flight	S	S	N	S	S	R	G	R	R1	N	G	N	N
4.06	Autorotation descent (non-emergency)	R	S	N	S	S	R	G	R	R1	N	G	G	N

OS(TP)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
5.01	Instrument take-off	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.02	SID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.03	Basic instrument flying skills (straight and level, turns, steep turns, speed changes, climbs and descents)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.04	Standard terminal arrivals/FMS arrivals	S	S	N	S	S	N	N	N	N	S	G	G	G
5.05	Initial and final approach checks	S	S	N	S	S	N	N	N	N	S	G	G	G
5.06	Holding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.07	Precision approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.08	Non-precision instrument approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.09	Conduct airborne radar approaches (ARA)	S	S	N	S	S	N	N	N	N	S	G	R	G
5.10	Missed approach/go-around	S	S	N	S	S	N	N	R	R1	S	G	G	G
5.11	Inadvertent entry into IMC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.01	Final approach/pre-landing checks	S	S	N	S	S	N	N	N	N	N	G	N	N
6.02	Confined area/ elevated helipad approaches	S	S	N	S	S	R	S	R	R	N	G	R	N
6.03	Downwind approaches	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.04	Quick stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.05	Transitions to the hover	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6.06	PC1/2/3 normal and crosswind approaches	S	S	N	S	S	R	S	R	R	N	G	R	N
6.07	Reserved													
6.08	Vertical landings	S	S	R	S	S	R	S	R	R	N	G	R	N
6.09	Deck landings (ship)	S	S	S	S	S	R	S	R	R	N	S	R	N
6.10	Rig landings	S	S	S	S	S	R	S	R	R	N	S	R	N
6.11	Sloping ground landings	S	S	S	S	S	R	S	R	R	N	G	R	N
6.12	Snow/sand/dust landings	S	S	R	S	S	R	S	R	R	N	R	R	N
6.13	Running landings	S	S	S	S	S	R	S	R	R1	N	G	G	N
6.14	Confined area/ elevated helipad landings	S	S	S	S	S	R	S	R	R	N	S	R	N
6.15	Balked rig/deck landings	S	S	N	S	S	R	S	R	R	N	R	R	N
6.16	Post-landing checks	S	S	G	S	S	G	N	N	N	N	N	N	G

11. MALFUNCTIONS — MASTER MATRIX DATA

11.1 Malfunctions — Master Matrix Data — Training (T) —The introduction of a specific training task

MALFUNCTIONS (T)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
7.01	Stability augmentation malfunction in flight	R	R	N	R	R	N	N	N	N	N	G	N	N
7.02	Autopilot malfunction in flight	R	R	N	R	R	N	N	N	N	N	G	N	N
7.03	Engine fire on ground or in the hover	S	S	S	S	S	N	R	N	N	N	G	G	N
7.04	Engine fire in forward flight	R	R	N	R	R	N	N	N	N	N	G	N	N
7.05	Engine malfunctions	R	R	N	R	R	N	N	N	N	N	G	N	N
7.06	Airframe fire and smoke on ground or in the hover	R	R	R	R	R	N	R	N	N	N	G	G	N
7.07	Airframe fire and smoke in forward flight	R	R	N	R	R	N	N	N	N	N	G	N	N
7.08	Engine failure before CDP/rejected take-off	R	R	N	R	R	N	R	N	N	N	G	G	N
7.09	Engine failure after CDP (multi-engine)	R	R	N	R	R	N	R	N	N	N	G	G	N
7.10	OEI instrument approaches and go-around	R	R	N	R	R	N	N	N	N	S	G	G	N
7.11	OEI instrument approaches and landing	R	R	R	R	R	N	R	N	N	S	G	G	N
7.12	Autorotation to engine off landing	S	S	S	S	S	G	R	R	R1	N	G	G	N
7.13	Incipient vortex ring/power settling at altitude	R	R	N	R	R	R	R	R	N	N	G	N	N
7.14	Incipient vortex ring/power settling on approach	R	R	N	R	R	R	R	R	N	N	G	G	N
7.15	Recovery from unusual attitudes	G	G	N	G	G	N	N	G	N	N	G	N	N
7.16	MGB/IGB/TRGB chip detector/oil pressure warning in the hover	R	R	N	R	R	N	R	N	N	N	G	G	N
7.17	MGB/IGB/TRGB chip detector/oil pressure warning in forward flight	R	R	N	R	R	N	N	N	N	N	G	N	N
7.18	Hydraulic failure in the hover	S	S	S	S	S	N	R	N	N	N	G	G	N
7.19	Hydraulic failure in forward flight	R	R	N	R	R	N	N	N	N	N	G	N	N
7.20	Hydraulic jack stall (servo transparency)	R	R	N	R	R	N	G	N	N	N	G	N	N
7.21	Instrumentation/indication failure VFR	R	R	N	R	R	N	G	N	N	N	G	N	N
7.22	Instrumentation/indication failure IFR	R	R	N	R	R	N	N	N	N	N	G	G	N
7.23	DC system failure	R	R	N	R	R	N	N	N	N	N	G	N	N
7.24	AC system failure	R	R	N	R	R	N	N	N	N	N	G	N	N
7.25	Battery failure	R	R	N	R	R	N	N	N	N	N	G	N	N
7.26	Total electrical failure	R	R	N	R	R	N	N	N	N	N	G	N	N
7.27	Fuel transfer failure	S	S	N	S	G	N	N	N	N	N	G	N	N
7.28	Fuel supply malfunction	S	S	N	S	G	G	N	N	N	N	G	N	N
7.29	Landing gear malfunction	R	R	R	R	R	N	R	N	N	N	G	N	N
7.30	Loss of TR effectiveness	S	S	N	S	S	N	R	N	N	N	G	G	N
7.31	TR drive failure in the hover	R	R	R	R	R	N	R	N	N	N	G	G	N
7.32	TR drive failure in forward flight	R	R	R	R	R	G	R	N	R1	N	G	G	N
7.33	TR control failure in the hover	R	R	R	R	R	N	R	N	N	N	G	G	N

MALFUNCTIONS (T)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
7.34	TR control failure in forward flight	R	R	R	R	R	G	R	N	R1	N	G	G	N
7.35	Coupled control malfunction	S	S	S	S	S	N	R	N	N	N	G	G	N
7.36	Uncoupled control malfunction	S	S	N	S	S	N	N	N	N	N	G	N	N
7.37	Dynamic rollover	R	R	R	R	R	N	R	N	N	N	G	G	N
7.38	Severe vibration	R	R	N	R	R	R	N	G	N	N	G	N	N
7.39	Ground resonance	R	R	R	R	R	N	R	G	R1	N	G	G	N
7.40	Retreating blade stall	R	R	N	R	R	R	N	G	R1	N	G	N	N
7.41	Rotor and airframe icing	R	R	N	R	R	R	N	G	R1	N	G	N	N
7.42	Engine icing	R	R	N	R	R	G	N	G	N	N	G	N	N
7.43	Anti-icing system malfunctions	R	R	N	R	R	N	N	N	N	N	G	N	N
7.44	Ditching	R	R	R	R	R	N	R	N	N	N	G	R	N
7.45	FADEC failures	R	R	N	R	R	N	N	N	R1	N	G	N	N

11.2 Malfunctions — Master Matrix Data — Training-to-Proficiency (TP)

MALFUNCTIONS (TP)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
7.01	Stability augmentation malfunction in flight	S	S	N	S	S	N	N	N	R	N	G	N	N
7.02	Autopilot malfunction in flight	S	S	N	S	S	N	N	N	R	N	G	N	N
7.03	Engine fire on ground or in the hover	S	S	S	S	S	R	S	R	R	N	G	G	G
7.04	Engine fire in forward flight	S	S	N	S	S	N	N	N	R1	N	G	N	G
7.05	Engine malfunctions	S	S	N	S	S	N	N	N	R	N	G	N	G
7.06	Airframe fire and smoke on ground or in the hover	S	S	S	S	S	R	S	N	R	N	G	G	G
7.07	Airframe fire and smoke in forward flight	S	S	N	S	S	N	N	N	R1	N	G	N	G
7.08	Engine failure before CDP/rejected take-off	S	S	S	S	S	R	S	R	R	N	G	G	G
7.09	Engine failure after CDP (multi-engine)	S	S	N	S	S	R	S	R	R1	N	G	G	G
7.10	OEI instrument approaches and go-around	S	S	N	S	S	R	N	R	R1	S	G	G	G
7.11	OEI instrument approaches and landing	S	S	S	S	S	R	S	R	R1	S	G	G	G
7.12	Autorotation to engine off landing	S	S	S	S	S	R	S	R	R	N	G	G	G
7.13	Incipient vortex ring/power settling at altitude	R	R	N	R	R	R	R	R	R	N	G	N	N

MALFUNCTIONS (TP)

Task Number	Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment — ATC (Voice)
7.14	Incipient vortex ring/power settling on approach	R	R	N	R	R	R	R	R	R	N	G	G	N
7.15	Recovery from unusual attitudes	R	R	N	R	R	R	N	S	R	N	G	N	N
7.16	MGB/IGB/TRGB chip detector/oil pressure warning in the hover	S	S	S	S	S	R	S	R	R	N	G	G	G
7.17	MGB/IGB/TRGB chip detector/oil pressure warning in forward flight	S	S	N	S	S	R	N	R	R1	N	G	N	G
7.18	Hydraulic failure in the hover	S	S	S	S	S	R	S	R	R	N	G	G	G
7.19	Hydraulic failure in forward flight	S	S	N	S	S	R	N	R	R1	N	G	N	G
7.20	Hydraulic jack stall (servo transparency)	S	S	N	S	S	R	R	R	R	N	G	N	N
7.21	Instrumentation/indication failure VFR	S	S	N	S	S	N	R	N	N	N	G	N	N
7.22	Instrumentation/indication failure IFR	S	S	N	S	S	N	N	N	N	N	G	G	N
7.23	DC system failure	S	S	N	S	S	N	N	N	N	N	G	N	N
7.24	AC system failure	S	S	N	S	S	N	N	N	N	N	G	N	N
7.25	Battery failure	S	S	N	S	S	N	N	N	N	N	G	N	N
7.26	Total electrical failure	S	S	N	S	S	N	N	N	N	N	G	N	N
7.27	Fuel transfer failure	S	S	N	S	G	N	N	N	N	N	G	N	N
7.28	Fuel supply malfunction	S	S	N	S	G	G	N	N	N	N	G	N	N
7.29	Landing gear malfunction	S	S	S	S	S	R	R	R	R	N	G	N	G
7.30	Loss of TR effectiveness	S	S	N	S	S	R	S	R	R	N	G	G	N
7.31	TR drive failure in the hover	S	S	S	S	S	R	S	R	R	N	G	G	N
7.32	TR drive failure in forward flight	S	S	S	S	S	R	S	R	R	N	G	G	G
7.33	TR control failure in the hover	S	S	S	S	S	R	S	R	R	N	G	G	N
7.34	TR control failure in forward flight	S	S	S	S	S	R	S	R	R	N	G	G	G
7.35	Coupled control malfunction	S	S	S	S	S	N	S	R	R	N	G	G	N
7.36	Uncoupled control malfunction	S	S	N	S	S	N	N	R	R	N	G	N	N
7.37	Dynamic rollover	S	S	S	S	S	N	S	R	R	N	G	G	N
7.38	Severe vibration	S	S	N	S	S	R	N	R	N	N	G	N	N
7.39	Ground resonance	S	S	S	S	S	N	S	R	R	N	G	G	N
7.40	Retreating blade stall	S	S	N	S	S	R	N	R	R	N	G	N	N
7.41	Rotor and airframe icing	S	S	N	S	S	R	N	R	R	N	G	N	N
7.42	Engine icing	S	S	N	S	S	R	N	R	N	N	G	N	N
7.43	Anti-icing system malfunctions	S	S	N	S	S	N	N	N	N	N	G	N	N
7.44	Ditching	S	S	R	S	S	N	S	R	R	N	G	R	N
7.45	FADEC failures	S	S	N	S	S	N	N	N	R	N	G	N	N

Attachment A

MALFUNCTIONS AND ABNORMAL OPERATIONS

1.1 The ability to deal competently with malfunctions is often required for successful completion of training. However, specific malfunctions are rarely associated with individual licences or types of training; therefore they are included as a separate category in Appendix C to Part I, paragraph 11 of the training Master Matrix data. In the Master Matrix spreadsheet (see Appendix C, paragraph 1.2), the malfunction data are located in Tab *7. Malfunctions*.

1.2 Due to the specific nature of many malfunctions, most of the training (T) and training-to-proficiency (TP) tasks will need to be flown in a type-specific FSTD. A selection of common malfunction types (many of which are applicable to both single- and multi-engine helicopters) has been developed. This list is not intended to be comprehensive but should give training providers examples of what training or training-to-proficiency malfunction tasks can be achieved in a particular FSTD. When developing a particular training programme, malfunctions may be added or deleted as necessary.

1.3 Procedures for dealing with some situations common to most helicopters (e.g. vortex ring) may not require a type-specific FSTD. These procedures can be effectively trained in a representative FSTD because the actions required are similar.

1.4 While the simulation of the majority of malfunctions is based upon approved data, flight test data may not be available for some malfunctions or situations (e.g. tail rotor drive failure, retreating blade stall, rotor blade icing, etc.) and, even if some data are available, the reaction of the helicopter may not be predictable. Although it may not be possible to accurately replicate the state of the aircraft in the FSTD, valuable training may still be achieved. The goal of such training is to enable a trainee to recognize the situation, make a diagnosis and then take the appropriate remedial action. Regulators, operators, instructors and pilots undergoing training should be aware that, due to this potential unpredictability of the helicopter reaction, the fidelity of the simulation cannot be verified.

Attachment B

MULTI-CREW COOPERATION TRAINING REQUIREMENTS

1 INTRODUCTION

1.1 This Attachment provides guidance in the event that an applicant is required to have completed a course of Multi-Crew Cooperation (MCC) training prior to the issue of a first multi-pilot type rating, such as the basic pilot licensing requirements contained in Appendix 1 to JAR-FCL 2.261(d) or its EASA equivalent.

1.2 The practical flight training exercises may take place in any FSTD qualified for this purpose.

2 TECHNICAL STANDARDS

2.1 To be capable of being approved for MCC training by an NAA, an FSTD would typically require a complexity of systems, such as demonstrated by the following:

a) multi-engine **and** multi-pilot helicopter;

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

c) retractable landing gear;

d) anti-icing or de-icing systems;

e) fire detection and suppression system;

f) dual controls;

g) autopilot with upper modes (see related definition in Part II, Chapter 1);

h) 2 VHF transceivers;

i) 2 VHF NAV receivers (VOR, ILS, DME);

j) 1 ADF receiver;

k) 1 marker receiver;

l) 1 transponder;

m) global positioning system (GPS); and

n) weather radar.

2.2 In addition, the NAA may require that the indicators for the following systems should be located in the same positions on the instrument panels of both pilots:

a) airspeed;

b) flight attitude;

c) altimeter;

d) radio altimeter (if applicable);

e) HSI;

f) vertical speed;

g) ADF receiver (if applicable);

h) VOR, ILS, DME receivers;

i) marker receiver(if applicable); and

j) stop watch (if applicable).

2.3 The instructor should be able to monitor the crew, crew actions and instrument indications. When located onboard, the instructor should have an adequate view of the OTW forward view. When not located onboard, the instructor should be provided with a reasonable representation of an OTW view related to the crew's view out of the cockpit.

MANUAL OF CRITERIA FOR THE QUALIFICATION OF FLIGHT SIMULATION TRAINING DEVICES

Volume II
Helicopters

Part II
Flight Simulation Training Device Criteria

Chapter 1

GLOSSARY OF TERMS, ABBREVIATIONS AND UNITS

1.1 GLOSSARY OF TERMS

The terms used in this volume of the manual have the following meanings:

Acceleration segment. That portion of the take-off profile between the first and second segments with a level acceleration from V_{TOSS} to V_y.

Active force feedback. In the context of a Flight Controls System, active force feedback indicates a dynamic system that produces FSTD control forces accurately reflecting those of the helicopter in all phases of flight in normal, abnormal and emergency operations.

Airport. A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft and that could also include an area, whether on land or water or on a building or other structure or elsewhere, intended for landing or take-off by aircraft capable of descending or climbing vertically.

Note.— ICAO normally uses the term aerodrome *but the term* airport *is used throughout this manual*.

***Airspeed*.** Calibrated airspeed unless otherwise specified (knots).

Alternate engines/avionics. An FSTD which has simulation of an alternate engine/avionics fit.

Altitude. Pressure-altitude (ft) unless otherwise specified.

Approved data. Helicopter data collected by application of good engineering practice and accepted for use by the NAA. The preferred data sources are the helicopter manufacturers and/or original equipment manufacturers, however data supplied by other qualified sources may be considered.

Note.— For additional information see the guidance material in the Attachments to Part II of this volume of Doc 9625 and related reading material listed in Volume II, Part I, Chapter 9.

Approved subjective development. Use of a documented process, acceptable to the NAA, to resolve issues with approved data by use of specific measurements on the helicopter and/or documentation for helicopter operation and/or judgement by qualified personnel.

Atypical flight control response. A flight control dynamic response is considered atypical when it does not exhibit classic second order system behaviour.

Audited engineering simulation. A helicopter manufacturer's engineering simulator or engineering simulation which has undergone a review by the appropriate NAA and been found to be an acceptable source of supplemental engineering validation data.

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

Autopilot with upper modes. An autopilot system with the capability to provide autopilot and/or flight director tracking modes in addition to basic stability augmentation and attitude retention modes.

Bank. Bank/roll angle (degrees).

Basic operating mass (BOM). The empty mass of the helicopter plus the mass of the following: normal oil quantity; required crew members and their baggage; standard equipment; and, as applicable, lavatory servicing fluid and potable water.

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

Buffet. An aerodynamic excitation of an aircraft structure by separated airflows.

Category A. With respect to helicopters, means a multi-engine helicopter designed with engine and system isolation features specified in Annex 8, Part IVB, and capable of operations using take-off and landing data scheduled under a critical engine failure concept which assures adequate designated surface area and adequate performance capability for continued safe flight or safe rejected take-off.

Category B. With respect to helicopters, means a single-engine or multi-engine helicopter which does not meet Category A standards. Category B helicopters have no guaranteed capability to continue safe flight in the event of an engine failure, and a forced landing is assumed.

Checking (pilot proficiency). The comparison of the knowledge about a task, or the skill or ability to perform a task, against an established set of criteria to determine that the knowledge, skill, or ability observed meets, or exceeds, or does not meet those criteria.

Note.— The use of the words testing or checking depends on the NAA's preference, as they are very similar in meaning, and may be dependent on the outcome of the event, e.g. a step towards a licence issuance or a recurrent evaluation of competency.

Closed loop testing. A test method for which the flight control stimuli are generated by controllers which drive the FSTD to follow a defined target response.

Computer controlled helicopter (CCH). A helicopter where pilot control inputs are transferred and augmented via computers.

Confined area. A helicopter landing area surface whether natural or artificial which is bounded, limited, restricted, restrained, shut up or enclosed in a manner which affects the landings and take-offs.

Continuous field of view. A displayed image that has no gaps horizontally or vertically except those created by the cockpit structure.

Control sweep. Movement of the appropriate pilot controller from neutral to an extreme limit in one direction (forward, aft, right, left, up or down), a continuous movement back through neutral to the opposite extreme position and then a return to the initial position.

Convertible FSTD. An FSTD in which significant hardware, software, or a combination of both are changed so that the device becomes a replica of a different model or variant, usually of the same helicopter but sometimes of a different helicopter type. The same FSTD platform, motion and vibration systems, visual system, computers and necessary peripheral equipment can thus be used in more than one simulation.

Note.— The significance of the difference, as adjudged by the NAA, will dictate whether a complete separate QTG would be deemed as necessary. Otherwise, a supplemental section added to the original QTG may suffice.

Correct trend and magnitude (CT&M). A tolerance meaning the appropriate general direction of movement of the helicopter, or part thereof, with appropriate corresponding scale of forces, rates, accelerations, etc.

Critical engine parameter. The engine parameter that is the most appropriate measure of power for that engine.

Damping.

a) *Critical damping.* 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.

b) *Overdamped.* 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.

c) *Underdamped.* 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.

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.

Device qualified as T only. Training on this FSTD type may be credited towards the issuance of the associated licence, rating, or qualification.

Device qualified as TP**.** Training on this FSTD type may be credited towards the issuance of the associated licence, rating, or qualification and should include all tasks to the level of proficiency required. Testing and checking can additionally be conducted provided that training to proficiency has also been completed on a device of the same qualification type.

Driven. A test method where the input stimulus or variable is driven by automatic means, generally a computer input.

Engine control unit (ECU). Within this document, is the generic engine control term that includes mechanical and analogue devices, electronic engine control (EEC) and full authority digital engine control (FADEC).

Engineering simulation validation data. Validation data generated by an engineering simulation or engineering simulator that are acceptable to the NAA.

Evaluation (FSTD). The careful appraisal of an FSTD by the NAA to ascertain whether or not the criteria required for a specified qualification type are met.

Fidelity level. The level of realism assigned to each of the defined FSTD features:

Fidelity level — G. Where the fidelity level is G, the initial validation should be based on subjective evaluation against approved data where available, complemented if necessary by approved subjective development, to determine a reference data standard. Recurrent validations should be measured objectively against the reference data standard.

Fidelity level — N. Where the fidelity level is N, the FSTD feature is not required.

Fidelity level — R. Where the fidelity level is R, the initial validation should be based on objective evaluation against approved data, complemented if necessary by approved subjective development, to determine a reference data standard. Recurrent validations should be objectively measured against the reference data standard.

Fidelity level — S. Where the fidelity level is S, the initial and recurrent validation should be based on objective evaluation against approved data.

Note.— The definitions above may slightly differ as a function of feature category (aircraft, cueing or environment simulation). Refer to Volume II, Part I, Chapter 7 for complementary information.

Flight simulation training device (FSTD). A synthetic training device that is in compliance with the minimum requirements for FSTD qualification as described in this volume of Doc 9625.

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

Footprint test. A test conducted and recorded on the same FSTD, during the initial evaluation of that FSTD, to be used as the reference data standard for recurrent evaluations.

Free response. The response of the hands-off helicopter after completion of a control input or disturbance.

Frozen/locked. A test condition where a variable is held constant with time.

FSTD approval. Declaration of the extent to which an FSTD of a specified qualification type may be used by an operator or training organization as agreed by the NAA. It takes account of differences between helicopters and FSTDs and of the operating and training ability of the organization.

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

FSTD feature. Describes the characteristics of an FSTD for each of the 14 categories that have been used in Volume II, Part II, Appendix A of this manual for the definition of the general and technical requirements for FSTDs.

Note.— Only 13 of the 14 categories may be found in the Master Matrix. The last category is "miscellaneous", for the characteristics listed in Part I, Chapter 6, 6.1.14 of this Volume and including the Instructor Operating Station (IOS). It does not appear in the Master Matrix but is included in Appendix A to *Parts II and III.*

FSTD operator. The person, organization or enterprise directly responsible to the NAA for requesting and maintaining the qualification of a particular FSTD.

FSTD types. The five baseline FSTD types as defined in Volume II, Part I, Appendix B of this manual.

FSTD user. The person, organization or enterprise requesting training, checking or testing credits through the use of an FSTD.

Full sweep. See definition for "control sweep".

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

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

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

Note.— Refer to Table 7.1 in Chapter 7 of Part I for an expanded definition.

Ground effect. The change in aerodynamic characteristics due to modification of the rotor downwash and of the airflow around the helicopter, caused by proximity to the ground.

Ground reaction. Forces acting on the helicopter due to contact with the ground. These forces should include the effects of type of landing gear (e.g. skids), strut deflections, skid or tire friction, side forces, surface type (e.g. hard, soft) and structural/rotor contact, as applicable, and other appropriate aspects. These forces should change appropriately, for example, with weight and speed.

***Group of helicopters*.** Within this document only, a group of helicopters is defined as having certain common characteristics. These include, but are not limited to, similar: weight; performance and handling characteristics; flight control systems; and configuration to include: type and number of engines; configuration, rotational direction and number of rotors; and instrument panel layout (conventional or electronic instruments).

Note.— Simulation or representation of one unique helicopter type of the group of helicopters is acceptable.

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

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

Heavy gross mass. A mass chosen by the FSTD operator or data provider that is not less than 90 per cent of the maximum certificated mass of the helicopter being simulated.

Height. Height above ground = AGL (m or ft).

Helicopter performance data. Data used to certify the helicopter performance. The data are generally for a normalized representation of the helicopter fleet with a margin to ensure that the values represent the least performing case.

Note.— An example is the data used to generate Rotorcraft Flight Manual (RFM) values.

Heliport. An airport or a defined area of land, water or of a structure intended to be used wholly or in part for the arrival, departure and surface movement of helicopters.

Highlight brightness. The maximum displayed brightness.

Integrated testing. Testing of the FSTD such that all helicopter system models are active and contribute appropriately to the results.

Note 1.— None of the helicopter system models should be substituted with models or other algorithms intended for testing purposes only.

Note 2.— This testing should be accomplished by using controller displacements as the input. These controllers should represent the displacement of the pilot's controls and should have been calibrated.

Intended use. Completion of the training, testing or checking tasks as prescribed in Part I of this document.

Irreversible control system. A control system in which movement of the main or tail rotor will not backdrive the pilot's control in the cockpit.

Latency. Additional time, beyond that of the basic perceivable response time of the helicopter, due to the response of the FSTD.

Light gross mass. A mass chosen by the FSTD operator or data provider that is not more than 120 per cent of the BOM of the helicopter being simulated or as limited by the minimum practical operating mass of the test helicopter.

Note.— In some light helicopters this may not be possible and early coordination with the responsible NAA would be required.

Limited obstacle sector. The 150° sector within which obstacles may be permitted, provided the height of the obstacles is limited.

Manual testing. FSTD testing wherein the pilot conducts the test without computer inputs except for initial set-up. All modules of the simulation should be active.

Master qualification test guide (MQTG). The NAA-approved test guide that incorporates the results of tests acceptable to the authorities at the initial qualification. The MQTG, as amended, serves as the reference for future evaluations. It may have to be re-established if any approved changes occur to the device, but should still be compliant with the approved data.

Medium gross mass. A mass chosen by the FSTD operator or data provider that is within ± 10 per cent of the average of the numerical values of the BOM and the maximum certificated mass.

Nominal. Normal operational mass, configuration, speed, etc., for the flight segment specified.

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

Note.— Specific terms such as alternate, direct, secondary or back-up, may be used to define an actual level of degradation used in reference to computer-controlled helicopters.

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

Objective test. A quantitative assessment based on comparison to data.

Obstacle Free Sector. The 210° sector, extending outwards to a distance that will allow for an unobstructed departure path appropriate to the helicopter the helideck is intended to serve, within which no obstacles above helideck level are permitted. For helicopters operated in Performance Class 1 or 2 the horizontal extent of this distance will be compatible with the one-engine inoperative capability of the helicopter type to be used.

Operator. A person, organization or enterprise engaged in or offering to engage in obtaining and maintaining the qualification of an FSTD.

Passive force feedback. In the context of a Flight Controls System, a passive force feedback indicates a passive system that may be provided by a spring, or spring and damper arrangement and produces FSTD control forces that may or may not represent those of the helicopter in any phase of flight in normal, and in particular, abnormal and emergency operations.

Performance Class 1 (PC1) operations. Operations with performance such that, in the event of a critical engine failure, performance is available to enable the helicopter to continue the flight safely to an appropriate landing area, unless the failure occurs prior to reaching the take-off decision point (TDP) or after passing the landing decision point (LDP), in which cases the helicopter must be able to land within the rejected take-off or landing area.

Performance Class 2 (PC2) operations. Operations with performance such that, in the event of a critical engine failure, performance is available to enable the helicopter to continue the flight safely to an appropriate landing area, except when the failure occurs early during the take-off manoeuvre or late in the landing manoeuvre, in which cases a forced landing may be required.

Performance Class 3 (PC3) operations. Operations with performance such that, in the event of an engine failure at any time during the flight, a forced landing will be required.

Power lever angle (PLA). The angle of the pilot's primary engine control lever(s) or twist grips in the cockpit, which also may be referred to as throttle lever angle (TLA).

Primary flight controls. The primary flight controls include cyclic, collective and pedal controls.

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

***Pulse input*.** A step input to a control followed by an immediate return to the initial position.

Qualification test guide (QTG). The primary reference document used for the evaluation of an FSTD. It contains test results, statements of compliance and the other prescribed information to enable the evaluator to assess if the FSTD meets the test criteria described in this volume of Doc 9625.

Reference data standard. Data based on approved data where available, complemented if necessary by approved subjective development and including footprint test results. Tolerances for recurrent evaluation results should be applied against the reference data standard. This applies only where the fidelity level is G.

Representative (R). Defines the intermediate level of required fidelity for a given FSTD feature.

Note.— Refer to Table 7-1 in Chapter 7 of Part I for an expanded definition.

Reversible control system. A control system in which aerodynamic loading on the main or tail rotor will feedback to the pilot's flight controls.

Sideslip. Sideslip angle (degrees).

Snapshot. Presentation of one or more variables at a given instant in time.

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

Note.— Refer to Table 7-1 in Chapter 7 of Part I for an expanded definition.

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

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

Subjective test. A qualitative assessment based on established standards as interpreted by a suitably qualified person.

Take-off decision point (TDP). The point used in determining take-off performance from which, an engine failure having been recognized at this point, either a rejected take-off may be made or a take-off safely continued.

Take-off distance required (TODRH). Only applicable to PC1 helicopters. The horizontal distance required from the start of the take-off to the point at which V_{TOSS}, a selected height, and a positive climb gradient are achieved, following failure of the critical engine being recognized at TDP, the remaining engine(s) operating within approved operating limits.

Note.— The selected height stated above is to be determined with the use of Rotorcraft Flight Manual data, and is to be at least 10.7 m (35 ft) above:

i) the take-off surface; or

ii) as an alternative, a level defined by the highest obstacle in the take-off distance required.

Take-off safety speed (V_{TOSS}). The minimum speed at which climb shall be achieved with the critical engine inoperative, the remaining engines operating within approved operating limits.

Testing (pilot proficiency). The comparison of the knowledge about a task, or the skill or ability to perform a task, against an established set of criteria to determine that the knowledge, skill, or ability observed meets, or exceeds, or does not meet those criteria.

Note.— The use of the words testing *or* checking *depends on the NAA's preference, as they are very similar in meaning, and their use may be dependent on the outcome of the event, e.g. a step towards a licence issuance, a recurrent evaluation of competency.*

Throttle lever angle (TLA). The angle of the pilot's primary engine control lever(s) or twist grips in the cockpit, which also may be referred to as power lever angle (PLA).

Time history. The presentation of the change of a variable with respect to time.

Train (T). The introduction of a specific training task. The training accomplished may be credited towards the issuance of a licence, rating, or qualification, but the training would not be completed to proficiency. The fidelity level of one or more of the simulation features may not support training-to-proficiency.

Note.— In the context of this definition, the word train *can be replaced by* training.

Train-to-proficiency (TP). The introduction, continuation, or completion of a specific training task. The training accomplished may be credited towards proficiency and/or the issuance of a licence, rating, or qualification, and the training is completed to proficiency. The fidelity level of all simulation features supports training-to-proficiency.

Note.— In the context of this definition, the words train-to-proficiency *can be replaced by* training-to-proficiency.

Transport delay. The FSTD system processing time required for an input signal from a pilot primary flight control until motion system, visual system and instrument response. It is a measure of the time from the flight control input through the hardware/software interface, through each of the host computer modules and back through the software/hardware interface to the motion system, flight instrument and visual system. Each of these three processing times excludes the helicopter dynamic response and represents the transport delay for that particular system. It is the overall time delay incurred from signal input until output response and is independent of the characteristic delay of the helicopter being simulated.

Update. The improvement or enhancement of an FSTD where it retains its existing qualification type.

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

Validation data. Data used to prove that the FSTD performance corresponds to that of the helicopter.

Validation Data Roadmap (VDR). A document from the helicopter validation data supplier that should clearly identify (in matrix format) the best possible sources of data for all required qualification tests in the QTG. It should also provide validity with respect to engine type and power rating and the revision levels of all avionics that affect helicopter handling qualities and performance.

Note.— See Attachment D to this Part of Doc 9625.

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 to establish a reference set of relevant parameters to which like FSTD parameters can be compared.

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

Vibration. An excitation resulting from structural interaction with rotor, engine, transmission, etc.

Visual ground segment. The visible distance on the ground, between the lower cut-off of the helicopter cockpit or the lowest point of the visual display and the furthest visible point, as limited by the prevailing visibility.

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

1.2 ABBREVIATIONS AND UNITS

The abbreviations and units used in this volume of Doc 9625 have the following meanings:

°	Degree
%	Per cent
A_d	Total initial displacement of pilot controller (initial displacement to final resting amplitude)
A_n	Sequential amplitude of overshoot after initial X-axis crossing (e.g. A_1 = first overshoot)
AC	Alternating Current
A/C	Aircraft
AFCS	Automatic Flight Control System
AGL	Above Ground Level (m or ft)
AHRS	Attitude and Heading Reference System
ANSI	American National Standards Institute
AOA	Angle of Attack (degrees)
AP	Autopilot
APU	Auxiliary Power Unit
APV	Approach Procedure with Vertical guidance
ARA	Airborne Radar Approach
ASE	Automatic Stabilization Equipment
ASOS	Automated Surface Observing System
ASR	Airport Surveillance Radar
ATA	Air Transport Association
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot Licence (Certificate or Type Rating)
AVAD	Automatic Voice Alerting Device
AWOS	Automated Weather Observation System

BC	ILS localizer back course
BITE	Built-in Test Equipment
BOM	Basic Operating Mass
CAP	Civil Aviation Publication
CAT I/II/III	Precision approach and landing operations category I/II/III
CAT A	Category A
CAT B	Category B
CCD	Charge-Coupled Device
CCH	Computer-Controlled Helicopter
cd/m^2	Candela/ $metre^2$ (3.426 3 $candela/m^2$ = 1 ft-lambert)
CDP	Critical Decision Point
CFIT	Controlled Flight Into Terrain
CG	Centre of Gravity
cm	Centimetre(s)
CPL	Commercial Pilot Licence
CT&M	Correct Trend and Magnitude
ctd	continued
daN	DecaNewtons
dB	Decibel
dBSPL	Decibel, Sound Pressure Level
DC	Direct Current
DGPS	Differential Global Positioning System
DH	Decision Height
DME	Distance Measuring Equipment
DOF	Degrees Of Freedom
DPATO	Defined Point After Take-Off
DPBL	Defined Point Before Landing
EASA	European Aviation Safety Agency
ECU	Engine Control Unit
EEC	Electronic Engine Control
EFIS	Electronic Flight Instrument System
EFVS	Enhanced Flight Vision System
EGPWS	Enhanced Ground Proximity Warning System
EGT	Exhaust Gas Temperature
Elec	Electrical
eQTG	Electronic Qualification Test Guide
ETL	Effective Translational Lift
FAA	Federal Aviation Administration (United States of America)
FADEC	Full Authority Digital Engine Control
FATO	Final Approach and Take-off Area
FCL	Flight Crew Licensing
FCOM	Flight Crew Operations Manual (or Operating Manual)
FD	Flight Director
Flt	Flight
FMS	Flight Management System
FOV	Field Of View
FPTD	Flight Procedures Training Device
FSTD	Flight Simulation Training Device

ft	Foot (1 ft = 0.304 801 m)
ft-lambert	Foot-lambert (1 ft-lambert = 3.426 3 candela/m^2)
ft/min	feet per minute (1 ft/min = 0.005 08 m/s)
G	Generic (as related to fidelity level)
g	Acceleration due to gravity (m/s^2 or ft/s^2; 1 g = 9.81 m/s^2 or 32.2 ft/s^2)
GBAS	Ground-Based Augmentation System
GLS	GBAS Landing System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
G/S	Glide Slope
HAA	Helicopter Acceleration Area
HAPI	Helicopter Approach Path Indicator
HGS	Head-up Guidance System
HMD	Helmet Mounted Display
HSI	Horizontal Situation Indicator
HTAWS	Helicopter Terrain Awareness Warning System
HUD	Head-Up Display
Hyd	Hydraulic
Hz	Unit of frequency (1 Hz = one cycle per second)
IAS	Indicated Airspeed
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IEC	International Electrotechnical Commission
IFR	Instrument Flight Rules
IG	Image generator
IGB	Intermediate Gearbox
IGE	In Ground Effect
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
in.	Inch(es) (1 in = 0.0254 m)
IOS	Instructor Operating Station
IPOM	Integrated Proof of Match
IR	Infrared
IR(I)	Instrument Rating (Initial)
IR(R)	Instrument Rating (Renewal)
IRS	Inertial reference system
JAA	European Joint Aviation Authorities
kg	Kilogram(s) (1 kg = 2.205 lb)
km	Kilometre(s) (1 km = 0.621 37 statute miles)
kPa	KiloPascal (kiloNewton/m^2) (1 psi = 6.894 76 kPa)
kt	Knots calibrated airspeed unless otherwise specified (1 knot = 0.514 4 m/s or 1.688 ft/s)
lb	Pound(s) (1 lb = 0.453 59 kg)
lbf	Pound-force (1 lbf = 4.4482 N)
LDAH	Landing Distance Available (Helicopter)
LDP	Landing decision point

LDRH	Landing Distance Required (Helicopter)
LOC-BC	ILS localizer Back Course
LOC/LLZ	ILS localizer
LOFT	Line-Oriented Flight Training
LOS	Limited Obstacle Sector or Line-Oriented Simulation (depending on context)
m	Metre(s) (1 m = 3.280 84 ft)
MAPt	Missed Approach Point
MCC	Multi-Crew Cooperation
MCP	Maximum Continuous Power
MCQFSTD	Manual of Criteria for the Qualification of Flight Simulation Training Devices
MCS	Motion Cueing System
MCTM	Maximum Certificated Take-off Mass (kg/lb)
MDA	Motion Drive Algorithm
MDA/H	Minimum Descent Altitude (Height)
MFD	Multi-Function Display
MGB	Main Gearbox
min	Minute(s)
MLG	Main Landing Gear
MLS	Microwave Landing System
MPa	MegaPascal(s) (1 psi = 6 894.76 Pascals)
MQTG	Master Qualification Test Guide
ms	Millisecond(s)
N	None (as related to fidelity level) or Normal control state referring to computer-controlled helicopters (depending on context)
n	Sequential period of a full cycle of oscillation
N/A	Not Applicable
N_1 or N_g	Engine or gas producer revolutions per minute, normally expressed in per cent of maximum
N_f	Free turbine speed (revolutions per minute, normally expressed in per cent of maximum)
N_p	Power turbine revolutions per minute, expressed in per cent of maximum
N_R	Rotor revolutions per minute, expressed in per cent of maximum or actual
NAA	National Aviation Authority
NAV	Navigation
NDB	Non-Directional Beacon
NM	Nautical Mile (1 NM = 1 852 m = 6 076 ft)
nm	nanometre (10^{-9} m)
NN	Non-Normal control state referring to computer-controlled helicopters
NOTAR	NO TAil Rotor
NVG	Night Vision Goggles
NVIS	Night Vision Imaging System
NWA	Nosewheel Angle (degrees)
OAT	Outside Air Temperature
OEI	One Engine Inoperative
OEM	Original Equipment Manufacturer
OFS	Obstacle Free Sector
OGE	Out of Ground Effect
OMCT	Objective Motion Cueing Test
OS	Operator Specific
OTD	Other Training Device
OTW	Out of the Window

P_0	Time from 90 per cent of the initial controller displacement until initial X-axis crossing (X-axis defined by the resting amplitude)
P_1	Period of first full cycle of oscillation after the initial X-axis crossing
P_2	Period of second full cycle of oscillation after the initial X-axis crossing
P_f	Impact or feel pressure
P_n	Sequential period of oscillation
Pa	Pascal(s)
PANS	Procedures for Air Navigation Services
PAPI	Precision Approach Path Indicator system
PAR	Precision Approach Radar
PC1	Performance Class 1
PC2	Performance Class 2
PC3	Performance Class 3
PFD	Primary Flight Display
PINS	Point In Space
PLA	Power Lever Angle
PLF	Power for Level Flight
POM	Proof of Match
PPL	Private Pilot Licence
PRM	Precision Runway Monitor
PSD	Power Spectral Density
psi	Pound(s) per square inch (1 psi = 6.894 76 kPa)
QFE	Altimeter setting related to a specific reference datum point (e.g. airport)
QNH	Altimeter setting related to mean sea level
QRH	Quick Reference Handbook
QTG	Qualification Test Guide
R	Representative (as related to fidelity level)
Rad	radian
RAeS	Royal Aeronautical Society
R/C	Rate of Climb (m/s or ft/min) (1 ft/min = 0.005 08 m/s)
R/D	Rate of Descent (m/s or ft/min)
Re	Take-off and Landing Recency
REIL	Runway End Identifier Lights
RFM	Rotorcraft Flight Manual
RGB	Red, Green and Blue
RL	Recurrent Licence Training and Checking
RMS	Root Mean Square
RNAV	Area Navigation
RNP	Required Navigation Performance
RNP AR APCH	RNP Authorization Required Approach
RPM	Revolutions per Minute
RTO	Rejected Take-Off
RTODAH	Rejected Take-Off Distance Available (Helicopter)
RTODRH	Rejected Take-Off Distance Required (Helicopter)
RVR	Runway Visual Range (m or ft)
S	Specific (as related to fidelity level)
s	Second(s)
SAAAR	Special Aircraft and Aircrew (flight crew) Approval Required
SAS	Stability Augmentation System

SBAS	Satellite-Based Augmentation System
SDF	Simplified Directional Facility
SID	Standard Instrument Departure
sm	Statute mile(s) (1 statute mile = 1 609 m = 5 280 ft)
SMGCS	Surface Movement Guidance and Control System
SOC	Statement of Compliance
STAR	Standard Instrument Arrival (also known as Standard Terminal arrival)
SUPPS	Regional Supplementary Procedures
T	Train(ing)
T(A)	Tolerance applied to amplitude
$T(A_d)$	Tolerance applied to residual amplitude
TACAN	Tactical Air Navigation
TAS	True Airspeed
TCAS	Traffic alert and Collision Avoidance System
TDP	Take-off Decision Point
TGL	Temporary Guidance Leaflet
TI	Thermal Imaging
TLA	Throttle Lever Angle
TLOF	Touchdown and Lift-off area
TP	Train(ing)-to-Proficiency
T(P)	Tolerance applied to period (context specific)
TR	Type Rating Training and Checking or Tail Rotor (depending on context)
TRG	Training
TRGB	Tail Rotor Gearbox
V_H	Maximum speed at level flight at MCP
V_{ne}	Never exceed speed
V_{TOSS}	Take-off Safety Speed
V_x	Best angle of climb speed
V_y	Best rate of climb Speed
VASIS	Visual Approach Slope Indicator system
VDR	Validation Data Roadmap
VFR	Visual Flight Rules
VGS	Visual Ground Segment
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional Radio Range
vs	versus
W/cm^2-sr	Watt(s) per steradian per square centimetre ($W\ cm^{-2}\ sr^{-1}$)

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Chapter 2

INTRODUCTION

2.1 PURPOSE

2.1.1 This volume of the manual establishes the performance and documentation requirements for evaluation by NAAs of helicopter FSTDs used for training, testing and checking of flight crew members. These requirements and methods of compliance were derived from the extensive experience of authorities and industry.

2.1.2 The manual is intended to provide the means for an NAA to qualify an FSTD, subsequent to a request by an applicant, through initial and recurrent evaluations of the FSTD. Further, the manual is intended to provide the means for the authorities of other States to accept the qualifications granted by the State which conducted the initial and recurrent evaluation of an FSTD, without repetitive evaluations, when considering approval of the use of that FSTD by applicants from their own State.

2.2 BACKGROUND

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

2.2.2 The FSTD requirements provided in this chapter are derived from training requirements which have been developed through a training task analysis, the details of which are fully presented in Part I of this Volume II. A summary of the FSTDs identified to support the training requirements is presented in the FSTD summary matrix (Table 2-1).

2.2.3 The summary matrix defines the baseline FSTD types by correlating training types against fidelity levels for key simulation features. Each of the baseline FSTD types is designed to be used in the training and, if applicable, testing and checking towards the associated licences or ratings. The terminology used in the table below for training type, device feature and device feature fidelity level are defined as follows:

2.2.3.1 Training types:

PPL — Private Pilot Licence;
CPL — Commercial Pilot Licence;
IR(I) —Instrument Rating (Initial);
IR(R) —Instrument Rating (Renewal);
ATPL — Airline Transport Pilot Licence or Certificate;
TR(I) —Type Rating Training and Checking (Initial);
RL — Recurrent Licence (Proficiency) Training and Checking;
Re — Recency (Take-off and Landing);
OS — Operator Specific; and
Mals — Malfunctions.

2.2.3.2 FSTD features:

Cockpit Layout and Structure
Flight Model (Aerodynamics and Engine)
Ground Handling
Helicopter Systems (ATA)
Flight Controls and Forces

Sound Cues
Visual Cues
Motion Cues
Vibration Cues

Environment (ATC)
Environment (Navigation)
Environment (Weather)
Environment (Heliports/Airports, Designated helicopter landing areas and Terrain)

Miscellaneous — (Instructor Operating Station, etc.)

2.2.3.3 Device feature fidelity level:

S (Specific)	—	Highest fidelity level
R (Representative)	—	Intermediate fidelity level
G (Generic)	—	Lowest fidelity level
N (None)	—	Feature not required

Note.— For detailed definitions of S, R, G and N please refer to Fidelity level *in the Glossary of Terms, Volume II, Part II, Chapter 1, Section 1.1*.

2.2.4 Training codes:

2.2.4.1 Device qualified as T only. The introduction of a specific training task. The training accomplished may be credited towards the issuance of a licence, rating or qualification, but the training would not be completed to proficiency. The fidelity level of one or more of the simulation features may not support training to proficiency.

2.2.4.2 Device qualified as TP. The introduction, continuation or completion of a specific training task. The training accomplished may be credited towards proficiency and/or the issuance of a licence, rating or qualification, and the training is completed to proficiency. The fidelity level of all simulation features supports training to proficiency.

Table 2-1. FSTD Summary Matrix

Device Type	**Cockpit Layout and Structure**	**Flight Model (Aero and Engine)**	**Ground Handling**	**Helicopter Systems (ATA)**	**Flight Controls and Forces**	**Sound Cue**	**Visual Display Cue**	**Vibration Cue**	**Motion Cue**	**Environment – Navigation**	**Environment – Weather**	**Environment – Landing Areas and Terrain**	**Environment – ATC (Voice)**
Type V	S	S	S	S	S	R	S	S	R	S	S	S	G
Type IV	S	S	S	S	S	R	S	S	R1	S	S	S	G
Type III	S	S	S	S	S	R	S	R	N	S	S	S	G
Type II (VFR)	R	R	G	R	R	G	S	G	N	S	R	R	G
Type I (IR)	R	R	G	R	R	G	G	G	N	S	G	G	G

2.2.5 Notes for special cases in the table:

2.2.5.1 The *Miscellaneous* feature category does not appear in the table.

2.2.5.2 Type IV — Motion cue — R1: the pilot receives an effective and representative motion cue and stimulus, which provides the appropriate sensations of acceleration of the helicopter's 6 degrees of freedom. Motion cues should always provide the correct sensation, to support the intended use. The sensation of motion can be less than in R fidelity level, the magnitude of the cues being reduced.

2.2.6 The FSTD general and technical requirements defined in Appendix A to this Part are grouped by device feature. The FSTD validation tests and functions and subjective tests found in Appendices B and C to this Part are grouped by device type.

2.2.7 Table 2-1 defines five baseline device types. The option still remains for an operator to define a unique device for specific training tasks. The process, utilizing Parts I and III of this Volume, is similar to that used to develop the five baseline device types. In very simple terms, one determines the training tasks and types, then obtains the FSTD features and fidelity levels to support the tasks as described in Part I, Chapter 3 of this Volume. The associated qualification and validation testing requirements for those feature fidelity levels are obtained through Part III of this Volume. If considering this process, the appropriate NAA should be consulted very early.

2.3 RELATED READING MATERIAL

Refer to Volume II, Part I, Chapter 9.

2.4 FLIGHT SIMULATION TRAINING DEVICE QUALIFICATION

2.4.1 In dealing with FSTDs, NAAs differentiate between the technical criteria of the FSTD and its use for training/testing and checking. Qualification is achieved by comparing the FSTD performance against the criteria specified in the Qualification Test Guide (QTG) for the qualification type sought.

2.4.2 The validation, functions and subjective tests required in the QTG enable the NAA to "spot check" the performance of the FSTD. Without such "spot checking," using the QTG, FSTD performance could not be verified in the time normally available for the authority's evaluation. It should be understood that the QTG does not perform a rigorous examination of the quality of the simulation in all areas of flight and systems operation. The full testing of the FSTD is intended to have been completed by the FSTD manufacturer/operator prior to the FSTD being offered to the NAA for evaluation and prior to the offer of the results in the QTG. This testing is a fundamental part of the whole cycle of testing and is normally carried out by following acceptance and testing procedures contained in documents which also provide a medium to record the test results. These documents will direct testing of the functionality and performance in many areas of the simulation that are not addressed in the QTG as well as such items as the Instructor Operating Station, etc.

2.4.3 Once the FSTD has been qualified, the authority responsible for supervision of the activities of the user of the FSTD can decide what training tasks can be carried out. This determination should be based on the FSTD qualification, the availability of FSTDs, the experience of the FSTD user, the training programme in which the FSTD is to be used and the experience and qualifications of the pilots to be trained. This latter process results in the approved use of an FSTD within an approved training programme.

2.5 TESTING FOR FLIGHT SIMULATION TRAINING DEVICE QUALIFICATION

2.5.1 The FSTD should be assessed in those areas which are essential to completing the flight crew member training, testing and checking process. This includes the FSTD's longitudinal and lateral-directional responses; performance in take-off, hover, hover taxi, climb, cruise, descent, autorotation, approach and landing; all-weather operations (if applicable); control checks; and pilot and instructor station functions checks. The motion, vibrations, visual and sound systems will be evaluated to ensure their proper operation.

2.5.2 The intent is to evaluate the FSTD as objectively as possible. Pilot acceptance, however, is also an important consideration. Therefore, the FSTD will be subjected to the validation tests listed in Appendix B to this Part and the functions and subjective tests in Appendix C. Validation tests are used to compare objectively FSTD and helicopter data to ensure that they agree within specified tolerances. Functions tests are objective tests of systems using helicopter documentation. Subjective tests provide a basis for evaluating FSTD capability to perform over a typical training period and to verify correct operation and handling characteristics of the FSTD.

2.5.3 Tolerances listed for parameters in Appendix B should not be confused with FSTD design tolerances and are the maximum acceptable for FSTD qualification.

2.5.4 The validation testing for initial and recurrent evaluations listed in Appendix B should be conducted in accordance with the FSTD type against approved data. An optional process for recurrent evaluation using MQTG results as reference data is described in Attachment H to this Part.

2.5.4.1 Where the fidelity level is S, the initial and recurrent evaluations should be based on objective evaluation against approved data. For evaluation of FSTDs representing a specific helicopter type, the helicopter manufacturer's validation flight test data are preferred. Data from other sources may be used, subject to the review and concurrence of the NAA responsible for the qualification. The tolerances listed in Appendix B are applicable for the initial evaluation. Alternatively, the recurrent evaluation can be based on objective evaluation against MQTG results as described in Attachment H.

2.5.4.2 Where the fidelity level is R, the initial and recurrent validation will be based on objective evaluation against approved data for the helicopter or group of helicopters with the exception of helicopter type-specific FSTDs (Type V motion and sound; Type IV motion; Type III vibration) where these evaluations are against helicopter type-specific data. For initial evaluation of FSTDs representing the helicopter or group of helicopters, the helicopter manufacturer's validation flight test data are preferred. Data from other sources may be used, subject to the review and concurrence of the NAA responsible for the qualification.

2.5.4.2.1 For motion, vibration and sound, where approved subjective development is submitted for the initial evaluation, the QTG should contain both:

a) the original objective test results showing compliance to the validation flight test data; and

b) the "improved" results, based upon approved subjective development against the validation flight test data. If approved subjective development is used, the MQTG result for those particular cases will become the reference data standard. Recurrent validations should be objectively measured against the reference data standard.

2.5.4.2.2 The tolerances listed in Appendix B are applicable for both initial and recurrent evaluations except where approved subjective development is used for motion, vibration and sound.

2.5.4.2.3 Alternatively, the recurrent evaluation can be based on objective evaluation against MQTG results as described in Attachment H to this Part.

2.5.4.3 Where the fidelity level is G, the initial validation will be based on evaluation against approved data where available, complemented if necessary by approved subjective development, to determine a reference data standard. Correct trend and magnitude (CT&M) tolerances can be used for the initial evaluation only. Recurrent validations should be objectively measured against the reference data standard. The tolerances listed in Appendix B are applicable for recurrent evaluations and should be applied to ensure the device remains at the standard initially qualified.

2.5.5 Requirements for generic or representative FSTD data are defined below.

2.5.5.1 Generic or representative data may be derived from a specific helicopter or group of helicopters. With the concurrence of the NAA, it may be in the form of a manufacturer's previously approved set of validation data for the applicable FSTD. Once the set of data for a specific FSTD has been accepted and approved by the NAA, it will become the validation data that will be used as reference for subsequent recurrent evaluations with the application of the stated tolerances.

2.5.5.2 The substantiation of the set of data used to build validation data should be in the form of a "Reference Data" engineering report and should show that the proposed validation data are representative of the helicopter or group of helicopters being modelled. This report may include flight test data, manufacturer's design data, information from the rotorcraft flight manual (RFM) and maintenance manuals, results of approved or commonly accepted simulations or predictive models, recognized theoretical results, information from the public domain, or other sources as deemed necessary by the FSTD manufacturer to substantiate the proposed model.

2.5.6 In the case of new helicopter programmes, the helicopter manufacturer's data, partially validated by flight test data, may be used in the interim qualification of the FSTD. However, the FSTD should be requalified following the release of the manufacturer's data after the type certification of the helicopter. The requalification schedule should be as agreed by the NAA, the FSTD operator, the FSTD manufacturer and the helicopter manufacturer. For additional information, refer to Attachment A to this Part.

2.5.7 FSTD operators seeking initial or upgrade evaluation of an FSTD should be aware that performance and handling data for older helicopters may not be of sufficient quality to meet some of the test standards contained in this volume of Doc 9625. In this instance it may be necessary for an FSTD operator to acquire additional flight test data.

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

2.5.9 Validation tests which do not meet the test criteria should be satisfactorily rectified or rationale provided with appropriate engineering judgment.

2.6 QUALIFICATION TEST GUIDE (QTG)

2.6.1 The QTG is the primary reference document used for the evaluation of an FSTD. It contains FSTD test results, statements of compliance and other information to enable the evaluator to assess if the FSTD meets the test criteria described in this volume of Doc 9625.

2.6.2 The applicant should submit a QTG which includes:

a) a title page including (as a minimum):

  1) the FSTD operator's name;

  2) helicopter model and series or group of helicopters, as applicable, being simulated;

  3) FSTD qualification type;

  4) NAA FSTD identification number;

  5) FSTD location;

  6) FSTD manufacturer's unique identification or serial number; and

  7) provision for dated signature blocks:

    i) one for the operator to attest that the FSTD has been tested using documented acceptance testing procedures covering cockpit layout, all simulated helicopter systems and the instructor operating station, as well as the engineering facilities, the motion, visual and other systems, as applicable;

    ii) one for the operator to attest that all manual validation tests have been conducted in a satisfactory manner using only procedures as contained in the QTG manual test procedure;

    iii) one for the operator to attest that the functions and subjective testing in accordance with Appendix C have been conducted in a satisfactory manner; and

    iv) one for the operator and the NAA indicating overall acceptance of the QTG.

b) an FSTD information page providing (as a minimum):

1) applicable regulatory qualification standards;

2) helicopter model and series or group of helicopters, as applicable, being simulated;

3) aerodynamic data revision;

4) engine model(s) and its data revision;

5) flight control data revision;

6) avionic equipment system identification and revision level where the revision level affects the training, testing and checking capability of the FSTD;

7) FSTD manufacturer;

8) date of FSTD manufacture;

9) FSTD computer identification;

10) visual system type and manufacturer;

11) motion system type and manufacturer;

12) vibration platform type and manufacturer;

13) designated qualification visual scenes as required; and

14) any supplemental information for additional areas of simulation which are not sufficiently important for the NAA to require a separate QTG;

c) table of contents to include a list of all QTG tests including all sub-cases, unless provided elsewhere in the QTG;

d) log of revisions and/or list of effective pages;

e) listing of reference and source data for simulator design and testing;

f) glossary of terms and symbols used;

g) statement of compliance (SOC) with certain requirements; SOCs should refer to sources of information and show compliance rationale to explain how the referenced material is used, applicable mathematical equations and parameter values and conclusions reached. Refer to the “Comments” column of Appendices A and B of Part II or III, as appropriate, for SOC requirements;

h) recording procedures and required equipment for the validation tests;

i) the following items for each validation test designated in Appendix B of Part II or III, as appropriate:

1) *Test number*. This should include the test number, which follows the numbering system set out in Appendix B.

2) *Test title*. This should be short and definitive, based on the test title referred to in Appendix B.

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

4) *Demonstration procedure*. This is a brief description of how the objective is to be met; it should describe clearly and distinctly how the FSTD will be set up and operated for each test when flown manually by the pilot and, when required, automatically tested.

5) *References*. These are references to the helicopter data source documents including both the document number and the page/condition number and, if applicable, any data query references.

6) *Initial conditions*. A full and comprehensive list of the FSTD initial conditions is required.

7) *Test parameters*. Provide a list of all parameters driven or constrained during the automatic test.

8) *Manual test procedures*. Procedures should be self contained and sufficient to enable the test to be flown by a qualified pilot, using reference to cockpit instrumentation. Reference to reference data or test results is encouraged for complex tests, as applicable. Manual tests should be capable of being conducted from either pilot seat, although the cockpit controller positions and forces may not necessarily be available from the other seat.

9) *Automatic test procedures*. A test identification number for automatic tests should be provided.

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

11) *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.

12) *Test result*. FSTD validation test results obtained by the FSTD operator from the FSTD. Tests run on a computer, which is independent of the FSTD, are not acceptable. The results should:

   i) be computer generated;

   ii) be produced on appropriate media acceptable to the NAA;

   iii) be time histories unless otherwise indicated and:

      (a) should plot for each test the list of recommended parameters (for future reference, a “Helicopter Flight Simulator Evaluation Handbook” should be produced; refer to Part I, Chapter 9, paragraph 9.3);

      (b) be clearly marked with appropriate time reference points to ensure an accurate comparison between FSTD and helicopter;

      (c) the FSTD result and validation data plotted should be clearly identified; and

      (d) in those cases where a “snapshot” result in lieu of a time history result is authorized, the FSTD operator should ensure that a steady state condition exists at the instant of time captured by the “snapshot”;

   iv) be clearly labelled as a product of the device being tested;

   v) have each page reflect the date and time completed;

vi) have each page reflect the test page number and the total number of pages in the test;

vii) have parameters with specified tolerances identified, with tolerance criteria and units given – automatic flagging of "out-of-tolerance" situations is encouraged; and

viii) have incremental scales on graphical presentations that provide the resolution necessary for evaluation of the tolerance parameters shown in Appendix B to Part II or III, as appropriate.

13) *Validation data*.

i) Computer-generated displays of flight test data overplotted with FSTD data should be provided. To ensure authenticity of the validation data, a copy of the original validation data, clearly marked with the document name, page number, the issuing organization and the test number and title as specified in 1) above, should also be provided;

ii) Helicopter data documents included in the QTG may be photographically reduced only if such reduction will not cause distortions or difficulties in scale interpretation or resolution; and

iii) Validation data variables should be defined in a nomenclature list along with sign convention. This list should be included at some appropriate location in the QTG.

14) *Comparison of results.* The accepted means of comparing FSTD test results to the validation data is overplotting;

j) a copy of the applicable regulatory qualification standards, or appropriate sections as applicable, used in the initial evaluation;

k) a copy of the VDR to clearly identify (in matrix format only) sources of data for all required tests including sound and vibration data documents; and

l) a copy of the engineering report that describes how the validation data were derived for the device (see Volume II, Part II, Attachment I for further information). This applies to non-type-specific devices only.

2.6.3 FSTD test results should be labelled using terminology common to helicopter parameters as opposed to computer software identifications. The QTG will provide the documented proof of compliance with the FSTD validation tests in Appendix B. For tests involving time histories, the overplotting of the FSTD data to helicopter data is essential to verify FSTD performance in each test. The evaluation serves to validate the FSTD test results given in the QTG.

2.7 MASTER QUALIFICATION TEST GUIDE (MQTG)

2.7.1 During the initial evaluation of an FSTD the MQTG is created. This is the master document, as amended in agreement with the NAA, to which FSTD recurrent evaluation test results are compared.

2.7.2 The MQTG is then available as the document to use for recurrent or special evaluations and is also the document that any NAA can use as proof of an evaluation and current qualifications of an FSTD when approval for the use of the particular FSTD is requested for a specific training task.

2.8 ELECTRONIC QUALIFICATION TEST GUIDE (EQTG)

Use of an eQTG can reduce costs, save time and improve timely communication and is becoming a common practice. ARINC Report 436 defines an eQTG standard.

2.9 QUALITY MANAGEMENT SYSTEM AND CONFIGURATION MANAGEMENT

2.9.1 A Quality Management System, which is acceptable to the NAA, should be established and maintained by the operator to ensure the correct maintenance and performance of the FSTD. The Quality Management System may be based upon established industry standards, such as ARINC Report 433 (15 May 2001 or as amended) entitled “Standard Measurements for Flight Simulator Quality”.

2.9.2 A configuration management system should be established and maintained to ensure the continued integrity of the hardware and software as from the original qualification standard, or as amended or modified through the same system.

2.10 TYPES OF EVALUATIONS

2.10.1 An initial evaluation is the first evaluation of an FSTD to qualify it for use. It consists of a technical review of the QTG and a subsequent on-site validation of the FSTD to ensure it meets all the requirements of this volume of Doc 9625.

2.10.2 Recurrent evaluations are those evaluations accomplished periodically to ensure that the FSTD continues to meet its qualification type.

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

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

b) a request for an upgrade for a higher qualification type; and

c) the discovery of a situation that indicates the FSTD is not performing at its initial qualification standard.

Note.— Some of the above circumstances may require establishing revised tests leading to an amendment of the MQTG.

2.11 CONDUCT OF EVALUATIONS

2.11.1 Initial FSTD evaluations

2.11.1.1 An FSTD operator seeking qualification of an FSTD should make the request for an evaluation to the NAA of the State in which the FSTD will be located.

2.11.1.2 The request for evaluation should provide the QTG and also include a statement that the FSTD has been thoroughly tested using a documented acceptance testing procedure covering cockpit layout, all simulated helicopter systems and the Instructor Operating Station as well as the engineering facilities, motion, visual and other systems, as applicable. In addition a statement should be provided that the FSTD meets the criteria described in this volume of Doc 9625. The applicant should further certify that all the QTG tests for the requested qualification type have been satisfactorily conducted. The NAA may request these statements in the form of a compliance statement to include the name and qualifications of the person(s) conducting the tests referred to in this paragraph.

2.11.1.3 A copy of the FSTD's QTG, with annotated test results, should accompany the request. Any QTG deficiencies raised by the NAA should be corrected prior to the start of the evaluation.

2.11.2 Modification of an FSTD

2.11.2.1 An **update** is a result of a change to the existing device where it retains its existing qualification type. The change may be approved through a recurrent evaluation or a special evaluation if deemed necessary by the NAA, according to the applicable regulations in effect at the time of initial qualification.

2.11.2.2 If such a change to an existing device would imply that the performance of the device could no longer meet the requirements at the time of initial qualification, but that the result of the change would, in the opinion of the NAA, clearly mean an improvement to the performance and training capabilities of the device altogether, then the NAA may accept the proposed change as an update while allowing the device to retain its original qualification type.

2.11.2.3 An **upgrade** is defined as the raising of the qualification type of a device, which can only be achieved by undergoing an initial qualification according to the latest applicable regulations.

2.11.2.4 In summary, as long as the qualification type of the device does not change, all changes made to the device should be considered to be updates pending approval by the NAA. An upgrade and consequent initial qualification according to latest regulations is applicable when the operator requests a higher qualification type for the FSTD.

2.11.3 Temporary deactivation of a currently qualified FSTD

2.11.3.1 In the event it is planned to remove an FSTD from active status for prolonged periods, the appropriate NAA should be notified and suitable controls established for the period the FSTD is inactive. If the FSTD has been inactive for an extended period of time pre-determined with the NAA, it may require an initial evaluation to current standards.

2.11.3.2 An understanding should be arranged with the NAA to ensure that the FSTD can be restored to active status at its originally qualified type.

2.11.4 Moving an FSTD to a new permanent location

2.11.4.1 In instances where an FSTD is to be moved to a new location, the appropriate NAA should be advised of the planned activity and provided with a schedule of events related thereto.

2.11.4.2 Prior to returning the FSTD to service at the new location, the operator will agree with the appropriate NAA which of the validation and functional tests from the QTG should be performed to ensure that the FSTD performance meets its original qualification standard. A copy of the test documentation should be retained with the FSTD records for review by the appropriate NAA.

2.11.5 Mobile FSTDs

2.11.5.1 In instances where an FSTD is designed to be relocated to various training locations, the appropriate NAA should be advised in the original application for an initial evaluation. For additional guidance see Volume II, Part II, Attachment Q.

2.11.5.2 The initial evaluation should be conducted with the FSTD in a "ready for training" state. As part of this process, the NAA will conduct another evaluation after the device has been moved to a new location to determine the capability of the device to withstand the rigour of the relocation move and to maintain the same standard as demonstrated during the initial evaluation. The relocation should be typical of that expected in service (i.e. method and preparation for relocation using the planned means of transportation, over an appropriate distance and under typically expected conditions).

2.11.5.3 For a subsequent relocation, the NAA will decide, in coordination with the operator, a post-relocation verification or alternatively which of the validation and functional tests from the QTG should be performed to ensure that the FSTD performance meets its original qualification standard. The NAA will also decide if it requires the conduct of a relocation evaluation. As confidence is gained that the integrity of the FSTD is not compromised during the relocations, the NAA may elect to permit unrestricted relocations of the FSTD with an established process for the operator to verify the FSTD performance prior to releasing it into service at the new location. A copy of the record of relocation, including the test results of the relocation verification process and any other pertinent documentation, should be retained with the FSTD records for review by the appropriate NAA.

2.11.6 Composition of an evaluation team

2.11.6.1 For the purposes of qualification of an FSTD, an evaluation team is usually led by a pilot inspector from the NAA along with engineers and a pilot qualified on type.

2.11.6.2 The applicant should provide technical assistance in the operation of the FSTD and the required test equipment. The applicant should make available a suitably knowledgeable person to assist the evaluation team as required.

2.11.6.3 On an initial evaluation, the FSTD manufacturer and/or helicopter manufacturer should have technical staff, such as a subject matter expert or a test pilot, available to assist as required.

2.11.7 FSTD qualification basis

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

2.11.7.2 The NAA having jurisdiction over the FSTD should establish the time interval between recurrent evaluations.

2.12 ADOPTION OF VOLUME II OF DOC 9625 INTO THE REGULATORY FRAMEWORK

The articulation of Volume II of Doc 9625 and its amendments into the regulatory framework is the responsibility of the various NAAs through national regulatory documents, such as 14 CFR Part 60, JAR-FSTD H or other equivalent document (refer to Volume II, Part I, Chapter 9).

2.13 FUTURE UPDATES OF THIS MANUAL

Appendix D to this Part describes the process to be used for proposed future updates to this document.

2.14 EVALUATION HANDBOOKS

At the time of preparation of this volume, no helicopter flight simulator evaluation handbook exists. However, the Royal Aeronautical Society is planning to develop and publish such a document. This will provide a useful source of guidance for conducting the tests required to establish that the FSTD under evaluation complies with the criteria set out in this volume.

Appendix A

FSTD REQUIREMENTS

INTRODUCTION

This appendix describes the minimum FSTD requirements for qualifying a device to an internationally agreed Type, as defined in Table 2-1 of this Part. The validation and functions and subjective tests listed in Appendices B and C to this Part should also be consulted when determining the requirements for qualification. Certain requirements included in this appendix should be supported with a statement of compliance (SOC) and, in some designated cases, an objective test. The SOC should describe how the requirement was met. The test results should show that the requirement has been attained. In the following tabular listing of FSTD criteria, requirements for SOCs are indicated in the comments column.

Certain feature fidelity levels are not currently used in the baseline standards types; however they may be associated with certain tasks within an operator-defined FSTD as per Part III, so that their definition is kept in the present appendix.

1. REQUIREMENT — COCKPIT LAYOUT AND STRUCTURE

1.	FEATURE GENERAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.S	An enclosed full scale replica of the helicopter cockpit, which should have fully functional controls, instruments and switches to support the intended use. Anything not required to be accessed by the flight crew in any mode of operation does not need to be functional. The level of enclosure must take into account the intended use.			✓	✓	✓	Helicopter-like windows should be provided to exclude distractions and achieve an enclosed perception. Chin windows, if present in the helicopter, should be replicated. A device approved for NVG training would require cockpit glazing which would provide realistic reflections from internal lighting.
1.R	An enclosed or perceived to be enclosed cockpit, excluding distraction and representative of a group of helicopters to support the intended use.	✓	✓				A device for NVG training should have cockpit glazing (reflection) if the helicopter has such characteristics.
1.G	An open, enclosed, or perceived to be enclosed, cockpit, excluding distraction, which will represent that of a group of helicopters to support the intended use.						

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.1	COCKPIT STRUCTURE						
1.1.1.S	<u>Cockpit (simulated area)</u>: An enclosed full scale replica of the cockpit of the helicopter being simulated including structure, bulkheads and panels; primary and secondary flight controls; engine and rotor controls; circuit breakers; flight instruments; navigation, communication and similar use equipment; caution and warning systems; emergency equipment and all other equipment and systems with associated controls and observable cockpit indicators. Additional required flight crew member duty stations and those required bulkheads aft of the pilots' seats containing items such as switches, circuit breakers and supplementary radio panels, to which the flight crew may require access during any event after pre-flight cockpit preparation is complete, are also considered part of the cockpit and should replicate the helicopter.			✓	✓	✓	<u>Cockpit (simulated area)</u>: *Note.— The cockpit, for flight simulation purposes, consists of all that space forward of a cross section of the fuselage at the most extreme aft setting of the flight crew members' seats or, if applicable, to that cross section immediately aft of additional flight crew member seats and/or required bulkheads.* Fitted systems or functions not required as part of the training programme are not required to be supported in the simulation software but any visible hardware and associated controls and switches should be fitted. Such systems, when part of any normal, abnormal or emergency cockpit procedure(s), should function to the extent required to replicate the helicopter during that procedure(s). Such systems or functions not supported in the simulation software should be identified on the FSTD QTG information page.
	<u>Instruments, panels and cockpit equipment</u>: The preceding should be properly located, functionally accurate and the tactile feel, technique, travel, effort and direction required to manipulate them within the correct range of movement, as applicable, should replicate those in the helicopter. (ctd on next page)			✓	✓	✓	Bulkheads containing only items such as landing gear pin storage compartments, fire axes or extinguishers, spare light bulbs, and aircraft document pouches, may be omitted. The items, or reasonable facsimile, if required by the training programme, should still be available but may be relocated to a suitable location as near as practical to the original position; otherwise they may also be omitted. Fire axes and any similar purpose instruments should be omitted or be represented in silhouette or by a photograph or a similar technique.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	Type I	Type II	Type III	Type IV	Type V	COMMENTS
	<u>Window replication</u>: Windows and chin windows, if any, should be included. The glazing should provide the reflection effects for the simulated helicopter, e.g. instrument reflections in night flight conditions, mirroring effects, etc. As applicable, equipment for operation of the cockpit windows should be included but the actual windows need not be operable. Chin windows, if present in the helicopter cockpit, should be replicated. Any window accessories and other helicopter parts visible within the visual field of view, e.g. wipers, demisting wiring, pitot tubes, handles, wire-cutters, should be replicated. A non-functional replica is acceptable and, in some cases, a silhouette may also be acceptable.			✓	✓	✓	<u>Instruments, panels and cockpit equipment</u>: The use of electronically displayed images with physical overlay or masking for FSTD instruments and/or instrument panels is acceptable provided: – all instruments and instrument panel layouts are dimensionally correct with differences, if any, being imperceptible to the pilot; – instruments replicate those of the helicopter including full instrument functionality and embedded logic, if any; – instruments displayed are free of quantization (stepping); – instrument display characteristics replicate those of the helicopter including: resolution, colours, luminance, fonts, fill patterns, line styles and symbology. The brightness should correspond to the appropriate lighting control setting; the maximum brightness should be tuned to the simulator lighting conditions;
	<u>Enclosure</u>: The cockpit, including any fitted instructor's station or observer seat, should be fully enclosed. (ctd on next page)			✓	✓	✓	– overlay or masking, including bezels and bugs, as applicable, replicates the helicopter panel(s); – instrument controls and switches replicate and operate with the same technique, effort, travel and in the same direction as those in the helicopter; – instrument lighting should replicate those of the helicopter; it should be operated from the same control (e.g. lighting panel) as in the helicopter; the logic of operation, e.g. the type of illumination dimmed with one specific button, should be as per the helicopter;

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	Type I	Type II	Type III	Type IV	Type V	COMMENTS
							– as applicable, instruments should have faceplates that replicate those in the helicopter; and – for three-dimensional instruments, such as an electro–mechanical instrument, the display image should appear to have the same: – perceived three-dimensional depth as the replicated instrument. The appearance of the simulated instrument, when viewed from any angle, should replicate that of the actual helicopter instrument. Any instrument reading inaccuracy due to viewing angle and parallax present in the actual helicopter instrument should be duplicated in the simulated instrument display image; and – typical vibrations as the instrument in the helicopter. The effects of vibration may be replicated by an animation of the displayed instrument image as long as there is no perceptible difference with the helicopter being simulated. <u>Circuit breakers</u>: All cockpit circuit breakers should replicate those in, and be located as in, the helicopter. Circuit breakers that affect procedures and/or result in observable cockpit indications should be functionally accurate. The tactile feel, technique, effort and direction required to manipulate the circuit breakers should replicate those in the helicopter.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.1.1.R	<u>Cockpit (simulated area)</u>:						<u>Cockpit (simulated area)</u>:
	An enclosed or perceived to be enclosed, spatially representative cockpit representing a group of helicopters and the configuration (including instrument panel layout) being simulated including representative: structure bulkheads and panels; primary and secondary flight controls; engine and rotor controls; circuit breakers; flight instruments; navigation, communications and similar use equipment; caution and warning systems; and all other equipment and systems with associated controls and observable cockpit indicators sufficient for the training events to be accomplished.	✓	✓				For FSTD purposes, the cockpit consists of all that space forward of a cross section of the cockpit at the most extreme aft setting of the flight crew members' seats or, if applicable, forward of that cross section immediately aft of additional crew member seats and/or required bulkheads. If the FSTD is used for VFR training, it should be a representation of the group of helicopters and of the configuration (including instrument panel and glare shield layout) comparable to the actual helicopter used for flight training.
	<u>Instruments, panels and cockpit equipment</u>:						<u>Instruments, panels and cockpit equipment</u>:
	The preceding should be properly located, functionally accurate and the technique, effort and direction required to manipulate them within the correct range of movement, as applicable, should be representative of those in the group of helicopters.	✓	✓				The use of electronically displayed images with physical overlay or masking for FSTD instruments and/or instrument panels is acceptable provided it incorporates operable controls representative of those in the helicopter. The instruments displayed should be free of quantization (stepping).
	<u>Window replication</u>:						<u>Circuit breakers</u>:
	Windows and chin windows, if any, should be included. Window accessories may be omitted. (ctd on next page)	✓	✓				A representative circuit breaker panel(s) should be presented (photographic reproductions are acceptable) and located in a spatially representative location(s). Only those circuit breakers used in a normal, abnormal or emergency procedure need to be simulated, in a group representative form, and be functionally accurate.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	Type I	Type II	Type III	Type IV	Type V	COMMENTS
	<u>Enclosure</u>: The cockpit enclosure needs only to be representative of that in the group of helicopters being simulated. The enclosure needs only to extend to the aft end of the cockpit and does not need to enclose the instructor station.						<u>Enclosure</u>: With the requirement for only a spatially representative cockpit, the physical dimensions of the enclosure may be acceptable to simulate more than one group of helicopters in a convertible FSTD. Each FSTD conversion should be representative of the group of helicopters being simulated which may require some controls, instruments, panels, masking, etc., to be changed for some conversions.
1.1.1.G	<u>Cockpit (simulated area)</u>: An open, enclosed or perceived to be enclosed cockpit area with helicopter-like primary and secondary flight controls, engine and rotor controls, equipment, systems, instruments, panels and associated controls sufficient for the training tasks to be accomplished, assembled in a spatially representative manner resembling that of the group of helicopters being simulated. The flight instrument panel(s) position and crew member seats should provide the crew member(s) with a representative posture at the controls and representative design eye position. <u>Enclosure</u>: An open, enclosed or perceived to be enclosed cockpit area, excluding distraction, which should be helicopter-like representative of a group of helicopters. The enclosure, if any, does not need to enclose the instructor station. (ctd on next page)						<u>Cockpit (simulated area)</u>: If the FSTD is used for any VFR training credit, it should be fitted with a representation of a glare shield that provides the crew member(s) with a representative design eye position comparable to that of the actual helicopter used for training. <u>Instruments, panels and cockpit equipment</u>: The assembled components should be compatible and function in a cohesive manner. The use of electronically displayed images with or without physical overlay or masking is acceptable. Operable controls should be incorporated if pilot input is required during training events. The instruments displayed should be free of quantization (stepping). "Helicopter-like" controls, instruments and equipment means as for the group of helicopters being simulated. If the FSTD is convertible, some may have to be changed for some conversions.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	Type I	Type II	Type III	Type IV	Type V	COMMENTS
							<u>Touch screen panels</u>: For CRM training, touch screen areas operated by both crew members should be capable of recognizing multiple contacts (multi-touch technology) in order to enable the crew to work simultaneously, e.g. on an inter-seat console or overhead area. <u>Circuit breakers</u>: Only those circuit breakers used in a normal, abnormal or emergency procedure need to be presented, simulated in a helicopter-like form, and be functionally accurate.
1.2	SEATING						
1.2.1	Flight crew members seating						
1.2.1.S	Flight crew member seats should replicate those in the helicopter being simulated.			✓	✓	✓	Helicopter cockpit observer seats are not considered to be additional flight crew member duty stations and may be omitted.
1.2.1.R	All flight crew member seats should represent those in the helicopter being simulated. They should afford the capability for the occupants to be able to achieve the design eye reference position established for the group of helicopters being simulated.	✓	✓				Helicopter cockpit observer seats are not considered to be additional flight crew member duty stations and may be omitted.
1.2.1.G	Flight crew member seats should provide the crew member(s) with a representative design eye position and have sufficient adjustment to allow the occupant to achieve proper posture at the controls as appropriate for the group of helicopters.						Helicopter cockpit observer seats are not considered to be additional flight crew member duty stations and may be omitted.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.2.2	Instructors and observers seating						
1.2.2.S	In addition to the flight crew member seats, there should be one instructor station seat and two suitable observer seats for an observer and an authority inspector either located on board or off board. When located on board, the location of the IOS seat and at least one of the observer seats should provide an adequate view of the pilots' panels and OTW forward view. When located off board, the instructor should be able to monitor the crew, crew actions and instrument indications, and he should be provided with a reasonable representation of an OTW view related to the crew's view out of the cockpit. When located off board, both observer seats should be provided with appropriate means for visual and audio monitoring of the training session (crew and instructor) as well as with the possibility to take notes. At least one of the seats should be provided with a reasonable representation of an OTW view related to the crew's view out of the cockpit.			✓	✓	✓	The instructor and observers seats need not represent those found in the helicopter. All three seats should be of adequate comfort for the occupant to remain seated for a two-hour training session. For an FSTD with a motion cueing system, any on-board instructor/observer seat(s) should be adequately secured and fitted with positive restraint devices of sufficient integrity to safely restrain the occupant during any known or predicted motion system excursion. Both observer seats should have adequate lighting to permit note taking and a system to permit selective monitoring of all flight crew member and instructor communications. The "reasonable representation of an OTW view related to the crew's view out of the cockpit" for the observer may be the same representation as for the instructor provided that the observer has an adequate OTW view without interfering with nor distracting the instructor. The Authority may consider options to this requirement based on unique cockpit configurations or training requirements.
1.2.2.R	In addition to the flight crew member seats, there should be one instructor station seat and two suitable seats for an observer and an authority inspector.	✓	✓				These seats need not be a replica of an aircraft seat and may be as simple as an office chair placed in an appropriate position.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.2.2.G	In addition to the flight crew member seats, there should be one instructor station seat and two suitable seats for an observer and an authority inspector.						These seats need not be a replica of an aircraft seat and may be as simple as an office chair placed in an appropriate position.
1.3	LIGHTING						
1.3.1	COCKPIT LIGHTING						
1.3.1.S	Cockpit lighting should replicate that in the helicopter.			✓	✓	✓	A subjective test is required.
1.3.1.R	Lighting environment for panels and instruments should be sufficient for the intended use.	✓	✓				Back-lighted panels and instruments may be installed but are not required.
1.3.1.G	Lighting environment for panels and instruments should be sufficient for the intended use.						Back-lighted panels and instruments may be installed but are not required.
1.3.1	AMBIENT LIGHTING						
1.3.2.S	Cockpit ambient lighting environment should be dynamically consistent with the visual display and sufficient for the intended use.			✓	✓	✓	The ambient lighting should provide an even level of illumination which is not distracting to the flight crew member(s). A subjective test is required.
1.3.2.R	The ambient lighting should provide an even level of illumination that is not distracting to the flight crew member(s).	✓	✓				A subjective test is required.
1.3.2.G	No special requirements for an ambient lighting, but the readability of the instruments should be ensured in all training situations.						A subjective test is required.

2. REQUIREMENT — FLIGHT MODEL

2.	FEATURE GENERAL REQUIREMENT FLIGHT MODEL	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.S	Aerodynamic and engine modelling for the helicopter being simulated, hovering IGE and OGE, including the effects of change in helicopter attitude, sideslip, altitude, temperature, gross mass, centre of gravity location and configuration to support the intended use.			✓	✓	✓	Effect of aerodynamic changes for various combinations of airspeed and power normally encountered in flight, including the effect of change in helicopter attitude, aerodynamic and propulsive forces and moments, relative wind, altitude, temperature, mass, centre of gravity location and configuration. Aerodynamic modelling which includes ground effect, effects of airframe and rotor icing (if applicable), aerodynamic interference effects between the rotor wake and fuselage, influence of the rotor on control and stabilization systems, and representations of non-linearities due to sideslip, vortex ring [settling with power] and retreating blade stall.
2.R	Aerodynamic and engine modelling should be representative of the appropriate group of helicopters according to design characteristics that affect the aerodynamic model.	✓	✓				It includes rotor design and configuration (teetering head, semi rigid, fully articulated and appropriate rotor direction of rotation), centre of gravity location, mass, altitude and temperature to include vortex ring [settling with power] and retreating blade stall.
2.G	Generic flight/engine model of a group of helicopters to support the intended use. This should include effects in the change of gross mass and centre of gravity.						It includes ground effect, translational lift and the differentiation between turbine and reciprocating engines.

	FEATURE TECHNICAL REQUIREMENT FLIGHT MODEL	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.1	FLIGHT DYNAMICS MODEL						
2.1.S	A flight dynamics model, including aerodynamic and engine modelling, that accounts for various combinations of airspeed and power normally encountered in flight including the effect of change in helicopter attitude, aerodynamic and rotor forces and moments, altitude, temperature, mass, centre of gravity location and configuration.			✓	✓	✓	
2.1.R	A flight dynamics model, including aerodynamic and engine modelling, that accounts for various combinations of airspeed and power normally encountered in flight including the effect of change in helicopter attitude, altitude, temperature, mass, centre of gravity location and configuration.	✓	✓				
2.1.G	A flight dynamics model helicopter-like (may be generic), including aerodynamic and engine modelling, that accounts for various combinations of airspeed and power normally encountered in flight including the effect of change in helicopter attitude, altitude, temperature, mass, centre of gravity location and configuration.						
2.2	AERODYNAMICS MODEL						For anti-icing, see also paragraph 4.4 of this Appendix.
2.2.S.a	Aerodynamics modelling that includes ground effect derived from type-specific flight test data. Applicable areas include flare and touchdown from a running landing as well as from IGE hover. An acceptable simulation of ground effect includes modelling of rotor efficiency, airframe drag, pitching moment, trim and power while in ground effect, and transition effect from IGE to OGE conditions and vice-versa.			✓	✓	✓	Validation flight test data should be used as the basis for flight and performance characteristics.

	FEATURE TECHNICAL REQUIREMENT FLIGHT MODEL	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.2.S.b	Aerodynamics modelling that includes the effects of icing, if applicable, on the airframe, the rotor aerodynamics and the engine. Icing models should simulate the aerodynamic degradation effects of ice accretion on the rotor lifting surfaces including loss of efficiency, effect on power setting, change in pitching, rolling moments, decrease in control effectiveness, and changes in control forces in addition to any overall increase in drag or helicopter gross mass with resulting effects on power.			✓	✓	✓	
2.2.S.c	Aerodynamics modelling that includes the effects of interference between the rotor wake and fuselage, influence of the rotor on control and stabilization systems, and representations of non-linearities due to sideslip, vortex ring [settling with power] and retreating blade stall.			✓	✓	✓	
2.2.R	Aerodynamics modelling, helicopter-like, derived from and appropriate to a group of helicopters to support the intended use and including ground effect, effects of airframe and rotor icing (if applicable), aerodynamic interference effects between the rotor wake and fuselage, influence of the rotor on control and stabilization systems, and representations of non-linearities due to sideslip, vortex ring [settling with power] and retreating blade stall.	✓	✓				Validation flight test data, tailored to the representation of the group of helicopters should be used as the basis for flight and performance characteristics.
2.2.G	Generic aerodynamics modelling, helicopter-like, to support the intended use, that may include ground effect, aerodynamic interference effects between the rotor wake and fuselage, influence of the rotor on control and stabilization systems, and representations of non-linearities due to sideslip.						Aerodynamic data do not need to be necessarily based on flight test data.

	FEATURE TECHNICAL REQUIREMENT FLIGHT MODEL	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.3	MASS PROPERTIES						
2.3.S	A type-specific helicopter mass properties model, including mass, centre of gravity location and moments of inertia as a function of payload and fuel loading should be implemented.			✓	✓	✓	
2.3.R	A representative, helicopter-like, mass properties model to support the intended use and including mass, centre of gravity and moments of inertia as a function of payload and fuel loading should be implemented.	✓	✓				
2.3.G	A generic, helicopter-like, mass properties model to support the intended use and including mass, centre of gravity and moments of inertia as a function of payload and fuel loading should be implemented.						

3. REQUIREMENT — GROUND REACTION AND HANDLING CHARACTERISTICS

3.	FEATURE GENERAL REQUIREMENT GROUND REACTION AND HANDLING CHARACTERISTICS	Type I	Type II	Type III	Type IV	Type V	COMMENTS
3.S	Ground handling to include the following: • ground reaction — reaction of the helicopter upon contact with the landing surface during landing to include strut deflections, tire or skid friction, side forces, and other appropriate parameters, such as weight and speed, necessary to identify the flight condition and configuration; and • ground taxiing characteristics — control inputs to include braking, deceleration turning radius and the effects of crosswind.			✓	✓	✓	Brake and tire failure dynamics and decreased brake efficiency should be specific to the helicopter being simulated. Stopping and directional control forces should be representative for all environmental landing conditions. Model to include strut/skid deflection, tire/skid friction, side forces, environmental effects and other appropriate parameters. It should also include stopping and directional control forces for various landing surface conditions based on helicopter related data, for a running landing. These conditions could include wet, dry, soft and hard, and icy surfaces for normal, slope and water landings.
3.R	Representative of a group of helicopters.						Representative steering/braking technique. Does not have to be type-specific.
3.G	Generic ground handling model. Helicopter-like, not specific to model, type or variant.	✓	✓				Distinction between wheel and skid should be available.

	FEATURE TECHNICAL REQUIREMENT GROUND REACTION AND HANDLING CHARACTERISTICS	Type I	Type II	Type III	Type IV	Type V	COMMENTS
3.1	GROUND REACTION AND HANDLING CHARACTERISTICS						
3.1.S	Ground handling to include the following: **ground reaction** — reaction of the helicopter upon contact with the landing surface during landing to include, but not be limited to, strut deflections, tire or skid friction, side forces, and other appropriate parameters, such as weight and speed, necessary to identify the flight condition and configuration; and **ground taxiing characteristics** — control inputs to include braking, deceleration, turning radius and the effects of crosswind.			✓	✓	✓	An SOC is required. Tests are required.
3.1.R	Representative ground handling of a helicopter or group of helicopters, e.g. medium twin; it does not have to be type-specific and is to include the following: **ground reaction** — reaction of the helicopter upon contact with the landing surface during landing to include, but not be limited to, strut deflections, tire or skid friction, side forces, and other appropriate parameters, such as weight and speed, necessary to identify the flight condition and configuration; and **ground taxiing characteristics** — control inputs to include braking, deceleration, turning radius and the effects of crosswind.						An SOC is required. Tests are required.
3.1.G	Generic ground reaction model and ground taxiing characteristics that are helicopter-like but not specific to model, type or variant.	✓	✓				

	FEATURE TECHNICAL REQUIREMENT GROUND REACTION AND HANDLING CHARACTERISTICS	Type I	Type II	Type III	Type IV	Type V	COMMENTS
3.2	LANDING SURFACE CONDITIONS						
3.2.S	Stopping and directional control forces for at least the following landing and take-off surface conditions based on helicopter-related data for a running landing, if appropriate for the helicopter area of operations and helicopter configuration: 1) dry; 2) wet (soft and hard surface); 3) icy; 4) patchy wet; 5) patchy ice; and 6) slope landings.			✓	✓	✓	An SOC is required. Subjective tests are required.
3.2.R	Stopping and directional control forces should be representative for at least the following landing surface conditions based on helicopter-related data for a running landing: 1) dry; and 2) wet.						
3.2.G	Stopping and directional control forces for dry landing surface conditions.	✓	✓				

	FEATURE TECHNICAL REQUIREMENT GROUND REACTION AND HANDLING CHARACTERISTICS	Type I	Type II	Type III	Type IV	Type V	COMMENTS
3.3	BRAKE AND TIRE FAILURES						
3.3.S	Brake and tire failure dynamics and decreased braking efficiency due to brake temperature, if applicable.			✓	✓	✓	An SOC is required.
3.3.R	N/A.						
3.3.G	N/A.						

4. REQUIREMENT — HELICOPTER SYSTEMS (ATA)

4.	FEATURE GENERAL REQUIREMENT HELICOPTER SYSTEMS	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.S	Helicopter systems should be type-specific and operative to the extent that normal and, where applicable, emergency and abnormal operating procedures appropriate to the training task can be accomplished.			✓	✓	✓	To include communications, navigation, caution and warning equipment (including audio warnings and other aural cues fed through headsets) corresponding to the helicopter. Circuit breakers required for operations should be functional. To include EVS, night vision goggles if required to support the intended use. The simulator should have controls that enable the instructor/evaluator to control all required system variables and insert all abnormal or emergency conditions into the simulated helicopter systems as described in an approved training programme, or as described in the relevant operating manual, as appropriate.
4.R	Helicopter systems should be representative of a group of helicopters and replicated with sufficient functionality for flight crew operation to support the intended use.	✓	✓				To include communications, navigation, caution and warning equipment (including audio warnings and other aural cues fed through headsets). System functionality should enable sufficient normal, and, where applicable, emergency and abnormal operating procedures to be accomplished. The simulator should have controls that enable the instructor/evaluator to control all required system variables and insert all abnormal or emergency conditions into the simulated helicopter systems as described in an approved training programme, or as described in the relevant operating manual, as appropriate.

4.	FEATURE GENERAL REQUIREMENT HELICOPTER SYSTEMS	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.G	Helicopter systems should be helicopter-like, not specific to model, type or variant, and should be replicated with sufficient functionality for flight crew operation to support the intended use.						To include communications equipment and aural cues fed through headsets, to support the intended use. System functionality should enable appropriate generic operating procedures to be accomplished, and should also allow the simulation of malfunctions, including instrument malfunctions.

	FEATURE TECHNICAL REQUIREMENT HELICOPTER SYSTEMS	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.1	NORMAL, ABNORMAL AND EMERGENCY SYSTEMS OPERATION						
4.1.S	All helicopter systems represented in the FSTD should simulate the specific helicopter type systems operation including system interdependencies, both on the ground and in flight. Systems should be operative to the extent that all normal, abnormal and emergency operating procedures can be accomplished. NVG and EVS systems should be emulated when they are represented in the helicopter or when they form part of the intended training curriculum.			✓	✓	✓	Helicopter system operation should be predicated on, and traceable to, the system data supplied by the helicopter manufacturer, original equipment manufacturer or alternative approved data for the helicopter system or component such as the operations manual of the system. Once activated, proper systems operation should result from system management by the crew member and not require any further input from the instructor's controls.
4.1.R	Helicopter systems represented in the FSTD should simulate representative systems operation of a helicopter or group of helicopters including system interdependencies, both on the ground and in flight. Systems should be operative to the extent that applicable normal, abnormal, and emergency operating procedures included in the operator's training programmes can be accomplished.	✓	✓				Helicopter system operation should be predicated on, and traceable to, the system data supplied by the helicopter manufacturer, original equipment manufacturer or alternative approved data for the helicopter system or component, e.g. medium twin engine helicopter; it does not have to be type-specific. Once activated, proper systems operation should result from system management by the crew member and not require any further input from the instructor's controls.
4.1.G	The systems should be operative to the extent that it should be possible to perform normal, abnormal, and emergency operations as required for the approved training programme.						Once activated, proper systems operations should result from the system management by the crew member and not require any further input from the instructor's controls.

	FEATURE TECHNICAL REQUIREMENT HELICOPTER SYSTEMS	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.2	INSTRUMENT INDICATIONS						
4.2.S	All relevant instrument indications involved in the simulation of the helicopter should automatically respond to attitude changes of the helicopter, pilot inputs or changes in system status, as well as to any external stimulus relevant for the instrument or indication being simulated. This includes but is not limited to atmospheric disturbance, effects resulting from icing, radio signals such as radio navigation or GPS or any other source.			✓	✓	✓	Numerical values should be presented in the appropriate units.
4.2.R	All relevant instrument indications involved in the helicopter or group of helicopters being simulated should automatically respond to attitude changes of the helicopter, pilot inputs or changes in system status, as well as to atmospheric disturbance and also respond to effects resulting from icing.	✓	✓				Numerical values should be presented in the appropriate units.
4.2.G	All relevant instrument indications involved in the helicopter or group of helicopters being simulated should automatically respond to attitude changes of the helicopter, pilot inputs or changes in system status.						
4.3	COMMUNICATIONS, NAVIGATION, CAUTION AND WARNING SYSTEMS						
4.3.S	Communications, navigation, caution and warning equipment, including audio warnings and other aural cues fed through headsets, corresponding to that installed in a specific helicopter type should operate within the tolerances and operation characteristics prescribed for the applicable airborne equipment.			✓	✓	✓	Operation characteristics include any specific behaviour of the equipment being simulated, e.g. dependencies between two or more simulated systems in case of malfunctions or special operating limitations of general purpose equipment resulting from the integration in the helicopter type being simulated.

	FEATURE TECHNICAL REQUIREMENT HELICOPTER SYSTEMS	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.3.R	Communications, navigation, caution and warning equipment, including audio warnings and other aural cues fed through headsets, corresponding to that typically installed in a representative helicopter simulation should operate within the tolerances prescribed for the applicable airborne equipment.	✓	✓				
4.3.G	Communications equipment and aural cues fed through headsets, to support the intended use.						
4.4	ANTI-ICING SYSTEMS						For flight model icing effects, see also paragraph 2.2 of this Appendix.
4.4.S	Anti-icing systems corresponding to those installed in the specific helicopter type should operate with appropriate effects upon ice formation on airframe, engines and instrument sensors.			✓	✓	✓	
4.4.R	Anti-icing systems corresponding to those typically installed in that helicopter or group of helicopters should operate .	✓	✓				Simplified airframe and engine, including engine induction and pitot-static system, icing models with corresponding performance degradations due to icing should be provided. Effects of anti-icing/de-icing systems activation should also be present.
4.4.G	N/A.						

5. REQUIREMENT — FLIGHT CONTROLS AND FORCES

5.	FEATURE GENERAL REQUIREMENT FLIGHT CONTROLS AND FORCES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
5.S	Control forces and control travel should replicate those of the helicopter being simulated. Controls should react in the same manner as in the helicopter under the same flight conditions. Control displacement should generate the same effect as the helicopter under the same flight conditions. Control feel dynamics should replicate those of the helicopter being simulated.			✓	✓	✓	
5.R	Representative of a group of helicopters (e.g. pedal position with rotor direction), but it does not have to be type-specific.	✓	✓				Active force feedback required if appropriate (i.e. not required if not present on the aircraft, e.g. in fly-by-wire aircraft).
5.G	Helicopter-like, not specific to model, type or variant (e.g. no proportional force feedback required).						Active force feedback not essential.

	FEATURE TECHNICAL REQUIREMENT FLIGHT CONTROLS AND FORCES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
5.1	CONTROL FORCES AND TRAVEL						Testing of position versus force is not applicable if forces are generated solely by use of helicopter hardware in the FSTD.
5.1.S	Control forces and control travel should correspond to that of the helicopter being replicated. Control forces and travel should react in the same manner and generate the same effect as in the helicopter under the same flight and system conditions.			✓	✓	✓	Active force feedback required if appropriate to the helicopter installation.
5.1.R	Control forces and control travel should correspond to that of the group of helicopters being simulated. Control forces and travel should react in the same manner and generate the same effect as in the group of helicopters under the same flight and system conditions.	✓	✓				Active force feedback required if appropriate to the helicopter installation.
5.1.G	Control forces and control travel and resulting effect should broadly correspond to the group of helicopters being simulated.						Active force feedback not required. Control forces produced by a passive arrangement are acceptable.
5.2	CONTROL FEEL DYNAMICS						
5.2.S	Control feel dynamics should replicate those of the helicopter being simulated.			✓	✓	✓	See Part II, Appendix B, paragraph 3.2 for a discussion of acceptable methods of validating control dynamics. See Part II, Appendix B, tests 2.a.5 (control dynamics) for the required tests.
5.2.R	N/A.						
5.2.G	N/A.						

	FEATURE TECHNICAL REQUIREMENT FLIGHT CONTROLS AND FORCES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
5.3	CONTROL SYSTEM OPERATION						
5.3.S	Control systems should replicate helicopter operation for the normal and any non-normal modes including back-up systems and should reflect failures of associated systems. Appropriate cockpit indications and messages should be replicated.			✓	✓	✓	See Part II, Appendix C for applicable testing.
5.3.R	Control systems should replicate the group of helicopters operation for the normal and any non-normal modes including back-up systems and should reflect failures of associated systems. Appropriate cockpit indications and messages should be replicated.	✓	✓				See Part II, Appendix C for applicable testing.
5.3.G	Control systems should allow basic helicopter operation with appropriate cockpit indications.						See Part III, Appendix C for applicable testing.

6. REQUIREMENT — SOUND CUES

6.	FEATURE GENERAL REQUIREMENT SOUND CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
6.S	N/A.						
6.R	Realistic sound cues appropriate to the specific helicopter being simulated. Significant sounds perceptible to the flight crew during flight operations to support the intended use.			✓	✓	✓	Variable N_R (overspeed/underspeed), engine noise (e.g. compressor stall, surge), blade slap specific to target rotor system. The volume control should have an indication of sound level setting. Correlation with helicopter systems simulation and motion/vibration platform (when installed) should be ensured.
6.G	Helicopter-like, but not specific to model, type or variant.	✓	✓				Variable N_R, engine noise, blade slap. The volume control should have an indication of sound level setting. See helicopter ATA-systems specific audio covered separately in paragraph 4 of this Appendix.

	FEATURE TECHNICAL REQUIREMENT SOUND CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
6.1	SOUND SYSTEM						
6.1.R	Significant cockpit sounds during normal and abnormal operations corresponding to those of the helicopter, including engine, transmission, rotor and aircraft systems sounds as well as those which result from pilot- or instructor-induced actions.			✓	✓	✓	Sounds as a function of flight conditions: variable N_R, engine noise, blade slap, etc. Aircraft systems refers to components generating sound audible to the flight crew, such as pumps, motors, fans, vents air flow and wipers. An SOC is required. Tests are required. See Part II, Appendix B.
6.1.G	Sounds due to engine(s), transmission(s) and rotor(s) should be available, helicopter-like but not specific to model, type or variant.	✓	✓				Sounds as a function of flight conditions: variable N_R, engine noise, blade slap. Engine type (piston versus turbine) should be differentiated. An SOC is required.
6.2	CRASH SOUNDS						
6.2.R	The sound of a crash when the simulated helicopter exceeds limitations.			✓	✓	✓	
6.2.G	The sound of a crash when the simulated helicopter exceeds limitations.	✓	✓				
6.3	ENVIRONMENTAL SOUNDS						
6.3.R	Significant environmental sounds should be coordinated with the simulated weather.			✓	✓	✓	
6.3.G	Environmental sounds are not required. However, if present, they should be coordinated with the simulated weather.	✓	✓				

	FEATURE TECHNICAL REQUIREMENT SOUND CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
6.4	SOUND VOLUME						
6.4.R	The volume control should have an indication of sound level setting which meets all qualification requirements. Full volume should correspond to actual volume levels in the approved data set. When full volume is not selected, an indication of abnormal setting should be provided to the instructor.			✓	✓	✓	The indication of abnormal setting should consist of an annunciation on a main IOS page which is always visible to the instructor.
6.4.G	The volume control should have an indication of sound level setting which meets all qualification requirements. Full volume should correspond to actual volume level agreed at the initial evaluation. When full volume is not selected, an indication of abnormal setting should be provided to the instructor.	✓	✓				
6.5	SOUND DIRECTIONALITY						
6.5.R	Sound should be directionally representative.			✓	✓	✓	Although most steady state sounds originate above and behind, some specific sounds (e.g. skids impact during an asymmetric touchdown, windshield wipers …) should be directionally differentiated. An SOC is required.
6.5.G	Sound not required to be directional.	✓	✓				

7. REQUIREMENT — VISUAL DISPLAY CUES

7.	FEATURE GENERAL REQUIREMENT VISUAL DISPLAY CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
7.S	Continuous field of view specific to the helicopter being simulated from the handling pilot's normal eyepoint with detailed close-up perspective and textured representation of all ambient conditions for each pilot, to support the intended use. Visual cues to assess the rate of change of height, height AGL and translational displacements and rates, during take-off, low altitude/low airspeed manoeuvring, hover, and landing. Field of view: minimum field of view of 210 degrees horizontal by 60 degrees vertical. The vertical eyepoint reference is adjusted approximately 1/3 up and 2/3 down. Visual fidelity: the visual scene displays an identifiable horizon in day and night VFR conditions suitable for determining the helicopter attitude in the pitch, roll and yaw axes. The system should be capable of displaying contoured terrain at the resolution demanded by the environment. Landing area(s) provided should be visible from a distance sufficient to allow the pilot to establish, stabilize and maintain approach angles up to 45 degrees from 300 m (1 000 ft) AGL to the surface unless obstructed by the cockpit structure. Focus and clarity of terrain and ground objects should be sharp.		✓	✓	✓	✓	Field of view in the training device replicates the helicopter field of view without obstruction. Where appropriate for the training task(s), an extended FOV including chin windows should be provided. These tasks may include take-offs, departures, approaches and landings in confined areas, on sloping ground, in snow/sand/etc., on a rig or a ship, etc.

7.	FEATURE GENERAL REQUIREMENT VISUAL DISPLAY CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
7.R	Visual cues to assess the rate of change of height and translational displacements and rates, during take-off and landing. Field of view: minimum field of view of 180 degrees horizontal by 45 degrees vertical. The vertical eyepoint reference is adjusted 1/3 up and 2/3 down. Visual fidelity: the visual scene displays an identifiable horizon in day and night VFR conditions suitable for determining the helicopter attitude in the pitch, roll and yaw axes. Landing area(s) provided should be visible from a distance sufficient to allow the pilot to establish, stabilize and maintain approach angles up to 20 degrees from 300 m (1 000 ft) AGL to the surface unless obstructed by the cockpit structure. Focus and clarity of terrain and ground objects should be sharp.						
7.G	Field of view: minimum 45 degrees horizontal by 30 degrees vertical. Daylight, dusk or dawn, and night visual scenes adequate for instrument training with the capability to display sufficient scene content to recognize generic aerodromes, heliports, terrain and landmarks around the final approach and take-off (FATO) area and to successfully accomplish low airspeed/low altitude manoeuvres to include lift-off, hover, translational displacements, landing and touchdown.	✓					

7.	FEATURE GENERAL REQUIREMENT VISUAL DISPLAY CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
	Visual fidelity: the visual scene displays an identifiable horizon in day and night VFR conditions suitable for determining the helicopter attitude in the pitch and roll axes. If a landing area is provided, it should be visible from a distance sufficient to allow the pilot to establish, stabilize and maintain a shallow approach angle (less than 5 degrees) from 300 m (1 000 ft) AGL to the surface unless obstructed by cockpit structure.						

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
7.1	DISPLAY						The choice of the display system and of the field of view requirements should fully consider the intended use of the FSTD. The balance between training and testing/checking may influence the choice and geometry of the display system. In addition the diverse operational requirements should be addressed. Guidance on display types is provided in Attachment R to this Part.
7.1.S	A continuous FOV of at least 210 degrees horizontally and 60 degrees vertically for each pilot simultaneously. The image should be aligned to the pilot flying. The misalignment observed by the non-flying pilot should not exceed 20 degrees. The vertical FOV should be distributed such that 20 degrees is above the horizon and 40 degrees is below. Where the rotor blade tip path would be visible in the helicopter from the pilot eyepoint, it should be appropriately depicted. The system should be free from optical discontinuities and artefacts that create non-realistic cues.		✓	✓	✓	✓	The horizontal and vertical FOV distribution may be adjusted to cover the particular helicopter configuration. An SOC is required and should explain the geometry of the installation. See Part II, Appendix B (test 4.a.1, field of view). Joins in the display surface are allowed where required for transportation of mobile simulators, but should be minimized. The 20-degrees limitation may be extended to 24 degrees where practical considerations, such as dome size on large dual cockpit helicopters, make the increase necessary, provided that the FSTD operator can prove to the satisfaction of the qualifying authority that the quality of training will not be compromised.
7.1.R	A continuous FOV of at least 180 degrees horizontally and 45 degrees vertically for each pilot simultaneously. The image should be aligned to the pilot flying. The misalignment observed by the non-flying pilot should not exceed 20 degrees.						The horizontal and vertical FOV distribution may be adjusted to cover the particular helicopter configuration. An SOC is required and should explain the geometry of the installation. See Part II, Appendix B (test 4.a.1, field of view).

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
	The vertical FOV should be distributed such that 15 degrees is above the horizon and 30 degrees is below. Where the rotor blade tip path would be visible within the above FOV, it should be appropriately depicted. The system should be free from optical discontinuities and artefacts that create non-realistic cues.						Joins in the display surface are allowed where required for transportation of mobile simulators, but should be minimized. The 20-degrees limitation may be extended to 24 degrees where practical considerations, such as dome size on large dual cockpit helicopters, make the increase necessary, provided that the FSTD operator can prove to the satisfaction of the qualifying authority that the quality of training will not be compromised.
7.1.G	An FOV of at least 45 degrees horizontally and 30 degrees vertically for each pilot simultaneously. The image should be aligned to the pilot flying. The misalignment observed by the non-flying pilot should not exceed 20 degrees. Where the rotor blade tip path would be visible within the above FOV, it should be appropriately depicted. The minimum distance from the pilot's eye position to the surface of a direct view display may not be less than the distance to any front panel instrument.	✓					The horizontal and vertical FOV distribution may be adjusted to cover the particular helicopter configuration. See Part II, Appendix B (test 4.a.1, field of view). The 20-degrees limitation may be extended to 24 degrees where practical considerations, such as dome size on large dual cockpit helicopters, make the increase necessary, provided that the FSTD operator can prove to the satisfaction of the qualifying authority that the quality of training will not be compromised.
7.2	SURFACE RESOLUTION						
7.2.S	Surface resolution demonstrated by a test pattern of objects shown to occupy a visual angle of not greater than 2 arc minutes in the visual display used on a scene from the pilot's eyepoint.		✓	✓	✓	✓	An SOC is required containing calculations confirming the resolution. See Part II, Appendix B (test 4.a.3, surface resolution).
7.2.R	Surface resolution demonstrated by a test pattern of objects shown to occupy a visual angle of not greater than 3 arc minutes in the visual display used on a scene from the pilot's eyepoint.						An SOC is required containing calculations confirming the resolution. See Part II, Appendix B (test 4.a.3, surface resolution).

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
7.2.G	Surface resolution demonstrated by a test pattern of objects shown to occupy a visual angle of not greater than 4 arc minutes in the visual display used on a scene from the pilot's eyepoint.	✓					An SOC is required containing calculations confirming the resolution. See Part II, Appendix B (test 4.a.3, surface resolution).
7.3	LIGHT-POINT SIZE						
7.3.S	Light-point size — not greater than 5 arc minutes.		✓	✓	✓	✓	An SOC is required confirming that the test pattern represents lights used for airfield lighting. See Part II, Appendix B (test 4.a.4, light-point size).
7.3.R	Light-point size — not greater than 8 arc minutes.						An SOC is required confirming that the test pattern represents lights used for airfield lighting. See Part II, Appendix B (test 4.a.4, light-point size).
7.3.G	Light-point size — not greater than 8 arc minutes.	✓					An SOC is required confirming that the test pattern represents lights used for airfield lighting. See Part II, Appendix B (test 4.a.4, light-point size).
7.4	SURFACE CONTRAST RATIO						
7.4.S	Surface contrast ratio adequate to clearly identify image features — not less than 8:1.		✓	✓	✓	✓	See Part II, Appendix B (test 4.a.5, surface contrast ratio).
7.4.R	Surface contrast ratio adequate to identify surface features — not less than 5:1.						See Part II, Appendix B (test 4.a.5, surface contrast ratio).
7.4.G	Surface contrast ratio adequate for the intended use — not less than 4:1.	✓					See Part II, Appendix B (test 4.a.5, surface contrast ratio).
7.5	LIGHT-POINT CONTRAST RATIO						
7.5.S	Light-point contrast ratio sufficient to clearly identify illumination sources and light — not less than 25:1.		✓	✓	✓	✓	See Part II, Appendix B (test 4.a.6, light-point contrast ratio).
7.5.R	Light-point contrast ratio sufficient to identify light — not less than 10:1.						See Part II, Appendix B (test 4.a.6, light-point contrast ratio).
7.5.G	Light-point contrast ratio sufficient to identify lights — not less than 8:1.	✓					See Part II, Appendix B (test 4.a.6, light-point contrast ratio).

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
7.6	SYSTEM BRIGHTNESS						
7.6.S	System brightness should be demonstrated using a raster drawn test pattern, be sufficient to appear like an average day and maintain contrast ratio. The surface brightness should not be less than 20 cd/m^2 (5.8 ft-lamberts).		✓	✓	✓	✓	See Part II, Appendix B (test 4.a.8, surface brightness).
7.6.R	System brightness should be demonstrated using a raster drawn test pattern, be sufficient to appear like an average day and maintain contrast ratio. The surface brightness should not be less than 14 cd/m^2 (4.1 ft-lamberts).						See Part II, Appendix B (test 4.a.8, surface brightness).
7.6.G	Sufficient to support the intended use.	✓					
7.7	BLACK LEVEL AND SEQUENTIAL CONTRAST						An explanation should be provided in cases where the test is not considered relevant to the display type.
7.7.S	The black level and sequential contrast need to be measured to determine that they are sufficient for training in all times of day.		✓	✓	✓	✓	See Part II, Appendix B (test 4.a.9, black level and sequential contrast).
7.7.R	The black level and sequential contrast need to be measured to determine that they are sufficient for training in all times of day.						
7.7.G	Suitable to support the intended use.	✓					
7.8	MOTION BLUR						An explanation should be provided in cases where the test is not considered relevant to the display type.
7.8.S	Tests are required to determine the amount of motion blur that is typical of certain types of display equipment. A test should be provided that demonstrates the amount of blurring at a pre-defined rate of movement across the image.		✓	✓	✓	✓	See Part II, Appendix B (test 4.a.10, motion blur).
7.8.R	Suitable to support the intended use.						
7.8.G	Suitable to support the intended use.	✓					

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
7.9	SPECKLE TEST						An explanation should be provided in cases where the test is not considered relevant to the display type. This test normally only applies to projectors using light sources with some degree of coherence.
7.9.S	A test is required to determine that the speckle typical of laser-based displays is below a distracting level.		✓	✓	✓	✓	See Part II, Appendix B (test 4.a.11, speckle test).
7.9.R	Suitable to support the intended use.						
7.9.G	Suitable to support the intended use.	✓					
7.10	HEAD-UP DISPLAY (where fitted)						Includes head mounted device or other device for displaying data overlaying the out of the window scene.
7.10.S	Display equipment should be provided as fitted in the helicopter cockpit. An active display (repeater) of all parameters displayed to the pilot should be located on the instructor operating station (IOS), or other location approved by the NAA. Display format of the repeater should represent that of the parameters displayed to the pilot.		✓	✓	✓	✓	An SOC is required. For non-collimated systems, only one display can be used by the pilot flying due to alignment with the out of the window displays. See Part II, Appendix B (test 4.b, head-up display) and Attachment K.
7.10.R	Display equipment should be provided as fitted in the helicopter cockpit, or the data may be displayed on the out of the window display. An active display (repeater) of all parameters displayed to the pilot should be located on the instructor operator station (IOS), or other location approved by the NAA. Display format of the repeater should represent that of the parameters displayed to the pilot.						An SOC is required. For non-collimated systems, only one display can be used by the pilot flying due to alignment with the out of the window displays. Where data are displayed outside the cockpit such as overlaid on the visual image, the data image should be controllable by the pilot as it is on the helicopter, and would only be applicable to single pilot operations. See Part II, Appendix B (test 4.b, head-up display) and Attachment K.

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
7.10.G	N/A.						
7.11	ENHANCED FLIGHT VISION SYSTEM (EFVS) (where fitted) – Including NVG						
7.11.S	The EFVS simulator hardware/software, including associated cockpit displays and annunciation, should function in the same way as, or in an equivalent manner to, the EFVS system installed in the helicopter. A minimum of one airport should be modelled for EFVS operation. The model should include an ILS and a non-precision approach (with VNAV if required for that helicopter type). Where a HUD image is used it (image and symbology) should be repeated as per the HUD requirement in 7.10.S of this Appendix. IOS weather presets should be provided for EFVS minimums.		✓	✓	✓	✓	For non-collimated systems, only one EFVS can be used by the pilot flying due to alignment display issues. See Part II, Appendix B (test 4.c, enhanced flight vision system) and Attachment L.
7.11.R	The EFVS simulator hardware/software, including associated cockpit displays and annunciation, should function in the same way as, or in an equivalent manner to, the EFVS system installed in the helicopter. A minimum of one airport should be modelled for EFVS operation. The model should include an ILS and a non-precision approach (with VNAV if required for that helicopter type).						Only one HUD/EFVS can be used by the pilot flying due to alignment display issues. Alternatively the EFVS may be presented as an inset in the visual scene representing the typical HUD FOV. See Part II, Appendix B (test 4.c, enhanced flight vision system) and Attachment L.
7.11.G	N/A.						

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
7.12	VISUAL GROUND SEGMENT						
7.12.S	A test is required to demonstrate that the visibility is correct on final approach in CAT II conditions and the positioning of the helicopter is correct relative to the runway.		✓	✓	✓	✓	See Part II, Appendix B (test 4.d, visual ground segment).
7.12.R	A test is required to demonstrate that the visibility is correct on final approach in CAT II conditions and the positioning of the helicopter is correct relative to the runway.						See Part II, Appendix B (test 4.d, visual ground segment).
7.12.G	A demonstration of suitable visibility is required.	✓					
7.13	ROTOR DOWNWASH EFFECTS						
7.13.S	The system should provide the ability to present the effect of re-circulating dust, water vapour, or snow conditions that develops as a result of rotor downwash. The effect is to be correlated with the surface type under the helicopter.		✓	✓	✓	✓	
7.13.R	N/A.						
7.13.G	N/A.						

8. REQUIREMENT — VIBRATION CUES

8.	FEATURE GENERAL REQUIREMENT VIBRATION CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
8.S	Characteristic type-specific vibrations/buffets that result from operation of the helicopter and which can be sensed in the cockpit.				✓	✓	Cue fidelity to incorporate all those provided by R fidelity in 8.R but specific to type, plus additional cues emanating from landing gear state, main rotor and tail rotor torque loading effects, and detailed malfunction effects (to include those associated with main rotor damper, vibration suppression systems, and anti-torque bearing/ coupling/gearbox/driveshaft).
8.R	Pilot receives effective and representative vibration cues.			✓			Cue fidelity to incorporate all those provided by G fidelity in 8.G, plus additional primary anti-torque system vibration cues (e.g. tail rotor, fenestron, NOTAR system), cues due to main rotor and anti-torque system blade tracking and balance effects, hydraulic system failures, icing effects, vortex ring [settling with power] state, autorotation and basic anti-torque system failure cues. Cues due to operation in the low relative speed environment (e.g. relative wind from all directions) and the high relative speed environment (e.g. retreating main rotor blade stall) should also be provided. All effects should be appropriate to a group of helicopters.
8.G	Pilot receives helicopter-like vibration cues.	✓	✓				Fundamental helicopter vibration cues, to include primary main rotor speed and disc loading cues, translational lift and speed change cues (acceleration and deceleration), and a general abnormal vibration cue.

	FEATURE TECHNICAL REQUIREMENT VIBRATION CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
8.1	VIBRATION CUES GENERAL						See Attachment P to this Part for guidance on vibration systems.
8.1.S	Characteristic buffet/vibration effects that result from operation of the helicopter should be present, in so far as the buffet/vibration marks an event or helicopter state that can be sensed in the cockpit. The FSTD should provide vibration and buffet effects programming to include the following: 1) Primary main rotor speed and disk loading vibration effects; 2) Buffet due to translational lift and effect of speed changes; 3) Runway rumble, oleo deflections, effects of ground speed, uneven runway, characteristics; 4) Buffets due to transverse flow effects; 5) Buffet during extension and retraction of landing gear (if applicable); 6) Buffet due to retreating blade stall; 7) Buffet due to vortex ring (settling with power); 8) Representative cues resulting from touchdown; 9) High speed rotor vibrations; (ctd on next page)				✓	✓	An SOC is required. Motion vibrations tests are required and should include recorded results that allow the comparison of relative amplitudes versus frequency. The simulator should be programmed and instrumented in such a manner that the characteristic buffet modes can be measured and compared to helicopter data for test cases detailed in tests 3bis (vibrations) of Appendix B to this Part. For air turbulence, general purpose disturbance models are acceptable if, when used, they produce test results that approximate demonstrable flight test data.

	FEATURE TECHNICAL REQUIREMENT VIBRATION CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
	10) Buffet due to tire failure dynamics; 11) Buffet due to engine malfunction and damage; 12) Buffet due to airframe ground contact; 13) Vibration that results from atmospheric disturbances; and 14) Vibration due to icing effect. And any vibration/buffet effect characteristic of rotor and transmission system of the simulated helicopter type.						
8.1.R	The FSTD should provide vibration and buffet effects programming to include the following: 1) Primary main rotor speed and disk loading vibration effects; 2) Buffet due to translational lift and effect of speed changes; 3) Buffets due to transverse flow effects; 4) Buffet due to retreating blade stall; 5) Buffet due to vortex ring (settling with power); 6) High speed rotor vibrations; 7) Buffet due to engine malfunction and damage; (ctd on next page)			✓			Motion vibrations tests are required and should include recorded results that allow the comparison of relative amplitudes versus frequency. The simulator should be programmed and instrumented in such a manner that the characteristic buffet modes can be measured using a footprint principle data for the test cases detailed in tests 3bis (vibrations) of Part II, Appendix B.

	FEATURE TECHNICAL REQUIREMENT VIBRATION CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
	8) Buffet due to airframe ground contact; 9) Vibration that results from atmospheric disturbances; and 10) Vibration due to icing effect.						
8.1.G	The FSTD should have at least a vibration cueing system for characteristic helicopter vibrations noted at the pilot station(s) and should provide vibration and buffet effects programming to include the following: 1) Primary main rotor speed and disk loading vibration effects; 2) Buffet due to translational lift and effect of speed changes; and 3) Buffets due to abnormal system conditions.	✓	✓				

9. REQUIREMENT — MOTION CUES

9.	FEATURE GENERAL REQUIREMENT MOTION CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
9.S	N/A.						
9.R	Pilot receives an effective and representative motion cue and stimulus, which provides the appropriate sensations of acceleration of the helicopter's 6 DOF. Motion cues should always provide the correct sensation, to support the intended use.					✓	
9.R1	Pilot receives an effective and representative motion cue and stimulus, which provides the appropriate sensations of acceleration of the helicopter's 6 DOF. Motion cues should always provide the correct sensation, to support the intended use. The sensation of motion can be less than in 9.R, the magnitude of the cues being reduced.				✓		
9.G	N/A.						

	FEATURE TECHNICAL REQUIREMENT MOTION CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
9.1	MOTION CUES GENERAL						When motion systems have been added by the FSTD operator even though not required for that type of device for attracting specific credits, they will be assessed to ensure that they do not adversely affect the qualification of the FSTD.
9.1.R	Motion cues (force) in 6 DOF, as perceived by the pilot, should be representative of the simulated helicopter's motion in-flight and on the ground.					✓	An SOC is required. See Part II, Appendices B and C for the evaluation differences between R and R1 for this requirement.
9.1.R1	Motion cues (force) in 6 DOF, as perceived by the pilot, should be representative of the simulated helicopter's motion in-flight and on the ground.				✓		An SOC is required. See Part II, Appendices B and C for the evaluation differences between R and R1 for this requirement.
9.2	MOTION FORCE CUEING						
9.2.R	The motion (force cueing) system should produce cues perceived at the pilot reference position in 6 DOF (i.e. pitch, roll, yaw, heave, sway and surge).					✓	An SOC is required.
9.2.R1	The motion (force cueing) system should produce cues perceived at the pilot reference position in 6 DOF (i.e. pitch, roll, yaw, heave, sway and surge). The magnitude of the cues can be partially reduced and the perception of motion can be less.				✓		An SOC is required.

	FEATURE TECHNICAL REQUIREMENT MOTION CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
9.3	MOTION EFFECTS						
9.3.R	Motion effects should include characteristic buffets and bumps that result from operation of the helicopter, in so far as these mark an event or helicopter state that can be sensed in the cockpit.					✓	See Part II, Appendix C, table of functions and subjective tests (tests 13, motion and vibration effects).
9.3.R	1) Touchdown cues for main and nose gear or for skids, based on their geometry.					✓	Touchdown bumps should reflect the effects of lateral and directional cues resulting from crab or crosswind landings, as well as from rate of descent. Conduct several normal approaches with various rates of descent. Check that the motion cues for the touchdown bumps for each rate of descent are representative of the actual helicopter.
9.3.R	2) Tire failure dynamics. Simulate a single tire failure and a multiple tire failure.					✓	The pilot may notice some yawing with a multiple tire failure selected on the same side. This should require the use of the pedal to maintain control of the helicopter. Dependent on helicopter type, a single tire failure may not be noticed by the pilot and may not cause any special motion effect. Sound or vibration may be associated with the actual tire losing pressure.
9.3.R	3) Airframe ground strike (e.g. tail and pod strike). Tail-strikes can be checked by over-rotation of the helicopter at a quick stop or autorotation to the ground.					✓	The motion effect should be felt as a noticeable nose down pitching moment.
9.3.R1	Motion effects should include characteristic buffets and bumps that result from operation of the helicopter, in so far as these mark an event or helicopter state that can be sensed in the cockpit.				✓		See Part II, Appendix C, table of functions and subjective tests (tests 13, motion and vibration effects).

	FEATURE TECHNICAL REQUIREMENT MOTION CUES	Type I	Type II	Type III	Type IV	Type V	COMMENTS
9.3.R1	1) Touchdown cues for main and nose gear or for skids, based on their geometry.				✓		Touchdown bumps should reflect the effects of lateral and directional cues resulting from crab or crosswind landings, as well as from rate of descent. Conduct several normal approaches with various rates of descent. Check that the motion cues for the touchdown bumps for each rate of descent are representative of the actual helicopter.
9.3.R1	2) Tire failure dynamics. Simulate a single tire failure and a multiple tire failure.				✓		The pilot may notice some yawing with a multiple tire failure selected on the same side. This should require the use of the pedal to maintain control of the helicopter. Dependent on helicopter type, a single tire failure may not be noticed by the pilot and may not cause any special motion effect. Sound or vibration may be associated with the actual tire losing pressure.
9.3.R1	3) Airframe ground strike (e.g. tail and pod strike). Tail-strikes can be checked by over-rotation of the helicopter at a quick stop or autorotation to the ground.				✓		The motion effect should be felt as a noticeable nose down pitching moment.

10. REQUIREMENT — ENVIRONMENT — NAVIGATION

10	FEATURE GENERAL REQUIREMENT ENVIRONMENT — NAVIGATION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
10.S	**Navigational data with the corresponding approach facilities to support the intended use, such as GPS, VOR, DME, ILS, NDB, etc.**	✓	✓	✓	✓	✓	**Navigation aids should correspond to the real world and be usable within range without restriction unless intentionally reduced due to terrain or other obstructions.**
10.R	**N/A.**						
10.G	**N/A.**						

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — NAVIGATION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
10.1	NAVIGATION DATABASE						
10.1.S	Navigation database sufficient to support simulated helicopter systems for real world operations.	✓	✓	✓	✓	✓	
10.1.R	N/A.						
10.1.G	N/A.						
10.2	MINIMUM AIRPORT/HELIPORT REQUIREMENT						
10.2.S	Complete navigation database for at least one airport and/or heliport including regular updates.	✓	✓	✓	✓	✓	Regular updates means navigation database updates as mandated by the NAA. If GPS approaches are available at these airports or heliports, they should be supported if the helicopter is so equipped.
10.2.R	N/A.						
10.2.G	N/A.						
10.3	INSTRUCTOR CONTROLS						
10.3.S	Instructor controls of internal and external navigational aids.	✓	✓	✓	✓	✓	e.g. helicopter ILS glideslope receiver failure compared to ground facility glideslope failure.
10.3.R	N/A.						
10.3.G	N/A.						
10.4	ARRIVAL/DEPARTURE FEATURES						
10.4.S	Navigational data with all the corresponding standard arrival and departure procedures.	✓	✓	✓	✓	✓	
10.4.R	N/A.						
10.4.G	N/A.						

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — NAVIGATION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
10.5	NAVIGATION AIDS RANGE						
10.5.S	Navigational data with all the corresponding standard arrival and departure procedures.	✓	✓	✓	✓	✓	Navigation aids should correspond to the real world and be usable within range without restriction unless intentionally reduced due to terrain or other obstructions.
10.5.R	N/A.						
10.5.G	N/A.						

11. REQUIREMENT — ENVIRONMENT — ATMOSPHERE AND WEATHER

11	FEATURE GENERAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER	Type I	Type II	Type III	Type IV	Type V	COMMENTS
11.S	**Specific to the training task.**			✓	✓	✓	**Other atmospheric effects may include, but are not limited to, representations of:** **1) arctic sea smoke;** **2) katabatic winds;** **3) mountain effects (rotors, demarcation lines, etc.);** **4) rig exhaust turbulence;** **5) wind masking due to buildings, trees, etc.;** **6) turbulence and wind effects caused by topography and structures;** **7) wake vortices and downwash from other aircraft; and** **8) wind shear.**
11.R	**Fully integrated dynamic environment simulation including a representative atmosphere with weather effects to support the intended use.** **Environment simulation should include thunderstorms, turbulence, microbursts and appropriate types of precipitation.**		✓				**To include surface features (moving grass, sea surface).**
11.G	**Basic atmospheric model, pressure, temperature, visibility, cloud base and winds to support the intended use.** **The environment should be synchronized with appropriate helicopter and simulation features to provide integrity.**	✓					

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER	Type I	Type II	Type III	Type IV	Type V	COMMENTS
11.1	STANDARD ATMOSPHERE						
11.1.S	Simulation of the standard atmosphere including instructor control over key parameters. Other atmospheric effects, such as arctic sea smoke, katabatic winds, etc., that are required to support the intended use should be demonstrated.			✓	✓	✓	
11.1. R, G	Simulation of the standard representative atmosphere including instructor control over key parameters.	✓	✓				
11.2	WIND SHEAR						
11.2.S	The FSTD should employ wind shear models that provide training for recognition of wind shear phenomena.					✓	A subjective test is required. See Part II, Appendix C, table of functions and subjective tests (test 11.b.7, wind shear/microburst encounters).
11.2.R	N/A.						
11.2.G	N/A.						

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER	Type I	Type II	Type III	Type IV	Type V	COMMENTS
11.3	WEATHER EFFECTS						
11.3.S	Smooth transition between weather effects should be provided. The following weather effects as observed on the visual system should be simulated and respective instructor controls provided:						A subjective test is required. See Appendix C, table of functions and subjective tests (test 12.g, environmental effects). The intent of this capability is to demonstrate transition from VMC to IMC.
	1) multiple cloud layers with adjustable bases, tops, sky coverage and scud effect;			✓	✓	✓	
	2) storm cells activation and/or deactivation;			✓	✓	✓	
	3) visibility and RVR, including fog and patchy fog effects;			✓	✓	✓	An objective test is required. Refer to Part II, Appendix B (test 4.d, visual ground segment).
	4) effects of own aircraft external lighting;			✓	✓	✓	
	5) effects of airport or heliport lighting (including variable intensity and fog effects);			✓	✓	✓	
	6) surface contaminants (including wind blowing and rotor downwash/ recirculation effects);			✓	✓	✓	
	7) variable precipitation effects (rain, hail, snow);			✓	✓	✓	
	8) in-cloud airspeed effect; and			✓	✓	✓	
	9) gradual visibility changes entering and breaking out of cloud.			✓	✓	✓	

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER	Type I	Type II	Type III	Type IV	Type V	COMMENTS
11.3.R	Smooth transition between weather effects should be provided.						A subjective test is required. See Part II, Appendix C, table of functions and subjective tests (test 12.g, environmental effects).
	The following weather effects as observed on the visual system should be simulated and respective instructor controls provided:						The intent of this capability is to demonstrate transition from VMC to IMC.
	1) multiple cloud layers with adjustable bases, tops, sky coverage and scud effect;		✓				
	2) storm cells activation and/or deactivation;		✓				
	3) visibility and RVR, including fog effects;		✓				An objective test is required. Refer to Part II, Appendix B (test 4.d, visual ground segment).
	4) effects of own aircraft external lighting;		✓				
	5) surface contaminants and own aircraft downwash and recirculation effect;		✓				
	6) precipitation effects (rain, hail, snow); and		✓				
	7) gradual visibility changes entering and breaking out of cloud.		✓				
11.3 G	Smooth transition between weather effects should be provided.						A subjective test is required. See Part II, Appendix C, table of functions and subjective tests (test 12.g, environmental effects).
	The following weather effects as observed on the visual system should be simulated and respective instructor controls provided:						The intent of this capability is to demonstrate transition from VMC to IMC.
	1) a cloud layer with adjustable base and top; and	✓					
	2) visibility and RVR.	✓					

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER	Type I	Type II	Type III	Type IV	Type V	COMMENTS
11.4	INSTRUCTOR CONTROLS						
11.4.S	The following features should be simulated, with appropriate instructor controls provided:						A subjective test is required. See Part II, Appendix C, table of functions and subjective tests (test 17, instructor operating station).
	1) surface wind speed, direction and gusts;			✓	✓	✓	Where required for specific training tasks the following effects should be included: – katabatic winds; and – mountain effects (rotors, demarcation lines, etc.).
	2) intermediate and high altitude wind speed and direction;			✓	✓	✓	Where required for specific training tasks the following effects should be included: – wake vortices and downwash from other aircraft.
	3) thunderstorms and microbursts;			✓	✓	✓	
	4) turbulence; and			✓	✓	✓	Where required for specific training tasks the following effects should be included: – rig exhaust turbulence; – wind masking due to buildings, trees, etc.; and – turbulence and wind effects caused by topography and structures.
	5) wind shear.			✓	✓	✓	Where required for specific training tasks.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER	Type I	Type II	Type III	Type IV	Type V	COMMENTS
11.4.R	The following features should be simulated, with appropriate instructor controls provided:						A subjective test is required. See Part II, Appendix C, table of functions and subjective tests (test 17, instructor operating station).
	1) surface wind speed, direction and gusts;		✓				
	2) intermediate and high altitude wind speed and direction;		✓				
	3) thunderstorms and microbursts; and		✓				
	4) turbulence.		✓				
11.4.G	The following features should be simulated with appropriate instructor controls provided:						A subjective test is required. See Part II, Appendix C, table of functions and subjective tests (test 17, instructor operating station).
	1) wind speed and direction; and	✓					
	2) turbulence.	✓					

12. REQUIREMENT — ENVIRONMENT — LANDING AREAS AND TERRAIN

12.	FEATURE GENERAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	Type I	Type II	Type III	Type IV	Type V	COMMENTS
12.S	**<u>Helipad, heliport and/or airport</u>: correct terrain modelling, runway orientation, markings, lighting, dimensions and taxiways.** **<u>Terrain</u>: visual texturing to give sufficient cues to permit pilots to determine speed, altitude and position information to support the training task.** **Terrain and EGPWS databases should be matched.**			✓	✓	✓	**<u>Geospecific scene content</u>** **Daylight scene will include sky and terrain suitably coloured and textured to clearly identify aircraft attitude.** **Night scene will include stars, ground lights, and sufficient texture to clearly identify the aircraft attitude and differentiate between the terrain and sky.** **Colours and textures will represent a particular geographic area environment as appropriate to the training task, i.e. normal vegetation, desert, arctic, or jungle.** **Ground objects will be presented in sufficient quantity to permit orientation and alignment for ground reference manoeuvring (i.e. traffic pattern and/or high/low reconnaissance). All ground objects should be presented in proper size and perspective, presenting no distraction to the pilot.** **Day or night horizon representation can be obscured by multiple ragged or solid cloud layers adjustable for bottom and top of layer corresponding to the aircraft altitude.** **The scene should permit adjustable visibility obscuration (haze or fog) and present a representation of precipitation (rain and snow).** **Airborne or ground traffic capability.**

12.	FEATURE GENERAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	Type I	Type II	Type III	Type IV	Type V	COMMENTS
							Miscellaneous content — Downwash effects simulated within local environment, 3-D model of sea state as required for training, tree movement in confined areas, highly detailed close-up landing effects, sloping ground.
12.R	**Helipad, heliport or airport**: as for the generic requirement of 12.G plus at least one fully customized 3-D airport/heliport model. **Terrain**: to include topographical information, such as buildings, trees, obstacles (as well as other features, such as unprepared landing sites, confined areas, ships, rigs, if required.) that allows VFR navigation training. Interactive 3-D sea states should be included if required for training. **For VFR cross-country training**: the capability to replicate ground visual references and topographical features sufficient to support VFR navigation according to appropriate charts (typically 1:500 000, 1:250 000, 1:100 000 scale mapping).		✓				It should be representative of a typical airfield or landing site, including terrain surface (grass, tarmac) and characteristics (soft, hard, slippery) but not necessarily geospecific. Where the device is required to perform low visibility operations, there should be at least one airport scene with functionality to support the required approval level, e.g. low visibility taxi route with marker boards, stop bars, runway guard lights plus the required approach, runway and taxiway lighting. It should include whiteout/brownout, surface features (downwash, moving grass and sea surface). **Scene content** Daylight scene will include sky and terrain suitably coloured and textured to clearly identify aircraft attitude. Night scene will include stars, ground lights, and sufficient texture to clearly identify the aircraft attitude and differentiate between the terrain and sky. Colours and textures will represent a particular geographic area environment as appropriate to the training task, i.e. normal vegetation, desert, arctic, or jungle.

12.	FEATURE GENERAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	Type I	Type II	Type III	Type IV	Type V	COMMENTS
							Ground objects will be presented in sufficient quantity to permit orientation and alignment for ground reference manoeuvring (i.e. traffic pattern and/or high/low reconnaissance), hovering and taxiing. All ground objects should be presented in proper size and perspective, presenting no distraction to the pilot. Day or night horizon representation can be obscured by multiple ragged or solid cloud layers adjustable for bottom and top of layer corresponding to the aircraft altitude. The scene should permit adjustable visibility obscuration and present a representation of precipitation (rain and snow). Airborne or ground traffic capability.
12.G	Generic airport/heliport model(s) with terrain topographical features to support the intended use. It should have a visible horizon. Daylight, dusk, and night visual scenes with the capability to display sufficient scene content to recognize generic aerodromes, heliports, terrain, and landmarks around the final approach and take-off (FATO) area and to accomplish low airspeed/low altitude manoeuvres to include lift-off, hover, translation to and from the hover into forward flight, landing and touchdown adequate for instrument training.	✓					It should include runway and taxiway markings and lighting. A limited area flat world is acceptable. The rotor blade tip path plane should be visible. The daylight scene should include sky and terrain suitably coloured to clearly identify the aircraft attitude. The night scene should include stars, ground lights, and sufficient texture to clearly identify the aircraft attitude and differentiate between the terrain and sky.

12.	FEATURE GENERAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	Type I	Type II	Type III	Type IV	Type V	COMMENTS
							Day or night horizon representation can be obscured by a solid cloud layer adjustable for bottom and top of layer corresponding to the aircraft altitude. **The scene should permit adjustable obscuration (haze or fog).** **Terrain does not need to represent any geospecific location.**

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	Type I	Type II	Type III	Type IV	Type V	COMMENTS
12.1	AIRPORT/LANDING AREA SCENES						
12.1.S	The following is the minimum airport/landing area model content requirement to satisfy visual capability tests, and provide suitable visual cues to allow completion of all functions and subjective tests described in Appendix C to this Part. There should be at least the following airport/helicopter landing areas: – at least one (1) specific real world airport or heliport; and – at least three non-airport landing areas, as follows: • at least one (1) helicopter landing area situated on a substantially elevated surface with respect to the surrounding structures or terrain (e.g. building top, offshore oil rig); • at least one (1) helicopter landing area that meets the definition of a “confined landing area”; and • at least one (1) helicopter landing area on a sloped surface where the slope is at least 2.5°.			✓	✓	✓	The designated real-world airport or heliport should be part of the approved training programme. The selection of the airport or heliport scenes is to be agreed with the NAA. *Note.— The requirements should be read in conjunction with Part II, Appendix C, table of functions and subjective tests (test 12, visual system) to fully understand the details to be provided.*

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	Type I	Type II	Type III	Type IV	Type V	COMMENTS
12.1.R	A minimum of one (1) airport or heliport and one (1) helicopter landing area model. The airport or heliport and the helicopter landing area may be contained within the same model. If this option is selected, the approach path to the airport runway(s) and the approach path to the helicopter landing area should be different.		✓				The fidelity of the visual scene should be sufficient for the aircrew to: visually identify the airport and/or helicopter landing area; determine the position of the simulated helicopter within the visual scene; successfully accomplish take-offs, approaches and landings; and manoeuvre around the airport on the ground, or in hover taxi, as necessary. The airport, heliport or helicopter landing area may be either fictional or real-world. *Note.— The requirements should be read in conjunction with Part II, Appendix C, table of functions and subjective tests (test 12, visual system) to fully understand the details to be provided.*
12.1.G	The system should include a generic airport with a helicopter landing area available.	✓					*Note.— The requirements should be read in conjunction with Part II, Appendix C, table of functions and subjective tests (test 12, visual system) to fully understand the details to be provided.*
12.2	AIRPORT OR HELIPORT CURRENCY						
12.2.S	The specific airport or heliport modelled in the system should be maintained current with the state of the corresponding real-world airport or heliport, as identified in the airport or heliport charts.			✓	✓	✓	The selection of the airport or heliport scenes to be agreed with the NAA. Changes should be incorporated in the simulator database within six months of being implemented in the corresponding real-world airport or heliport. An update is required when, for example, additional runways or taxiways are added; when existing runway(s) are lengthened or permanently closed; when magnetic bearings to or from a runway are changed; when significant and recognizable changes are made to the terminal, other buildings, or surrounding terrain, etc., but does not need to include changes to minor buildings or other less important features not represented on the airport or heliport charts.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	Type I	Type II	Type III	Type IV	Type V	COMMENTS
12.2.R	N/A.						
12.2.G	N/A.						
12.3	VISUAL ENVIRONMENT DETAIL						
12.3.S	Visual cues to assess sink rate and enable depth perception during take-off and landing should be provided. Highly detailed and accurate surface depiction of the terrain surface within an area sufficient to achieve cross-country flying under VFR conditions.			✓	✓	✓	Terrain surface references and topographical features should be adequate to navigate using appropriate charts (typically 1:500 000, 1:250 000, 1:100 000 scale mapping).
12.3.R	Visual cues to assess sink rate and enable depth perception during take-off and landing should be provided. Highly detailed and accurate surface depiction of the terrain surface within an approximate area from 400 m (1/4 sm) before to 400 m (1/4 sm) beyond the runway approach end with a total width of approximately 400 m (1/4 sm) including the width of the runway.		✓				
12.3.G	Textured surfaces to assess sink rate and enable depth perception during take-off and landing should be provided.	✓					
12.4	SCENE CONTENT						
12.4.S	The visual system should be capable of producing, as a minimum, scene content comparable in detail to that produced by 10 000 polygons and 5 000 visible light-points for night, dusk and day scenes for the entire visual system.			✓	✓	✓	

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	Type I	Type II	Type III	Type IV	Type V	COMMENTS
12.4.R	The visual system should be capable of producing, as a minimum, scene content comparable in detail to that produced by 6 000 polygons and 5 000 visible light-points for night, dusk and day scenes for the entire visual system.		✓				
12.4.G	The visual system should be capable of producing, as a minimum, scene content comparable in detail to that produced by 6 000 polygons and 1 000 visible light-points for night, dusk and day scenes for the entire visual system.	✓					
12.5	SPECIAL EFFECTS						
12.5.S	The following effects should be capable of being displayed: 1) downwash effects including brownout and whiteout; 2) sea states including the resulting movement of ships used for deck landings; 3) effects of wind lanes on water surface; 4) movement of trees and grass in confined area landing sites; and 5) ground static and moving traffic and airborne traffic capable of conflicting with own aircraft.			✓	✓	✓	Ship movement should at least conform to the sea state in pitch, roll and heave.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	Type I	Type II	Type III	Type IV	Type V	COMMENTS
12.5.R	The following effects should be capable of being displayed: 1) downwash effects including brownout and whiteout; 2) sea states including the resulting movement of ships used for deck landings; 3) effects of wind lanes on water surface; and 4) ground static and moving traffic and airborne traffic capable of conflicting with own aircraft.		✓				
12.5.G	N/A.						

13. REQUIREMENT — ENVIRONMENT — ATC

13.	FEATURE GENERAL REQUIREMENT ENVIRONMENT — ATC	Type I	Type II	Type III	Type IV	Type V	COMMENTS
13.S	Automated dynamic environment in the terminal area, including ATC responses to ownship voice transmissions and appropriate ATC initiated transmissions to support the intended use. Content and intensity of ownship and othership messages specific to airport or heliport context and frequency, in English (as per Doc 4444, *Procedures for Air Navigation Services – Air Traffic Management*). Randomized messages to ownship and othership messages specific to airport or heliport. Correlation with visual ground, landing and departing traffic, including terminal area simulation of airports or heliports appropriate to the training programme.						Recognizing that the implementation of a dynamic ATC environment has not yet been evaluated and verified through training, the progress towards this level is expected to take place over a period of time. Therefore the requirements listed for ATC environment in this section are intended as goals that should be achievable in the next few years but are recognized as not being required at this time.
13.R	Flight phase and content-specific ATC messages in the terminal area, including appropriate responses to ownship voice transmissions to support the intended use. Context and intensity of ownship and othership messages in English (as per Doc 4444, *Procedures for Air Navigation Services – Air Traffic Management*). Randomized messages to ownship and background messages representative of ATC control.						

13.	FEATURE GENERAL REQUIREMENT ENVIRONMENT — ATC	Type I	Type II	Type III	Type IV	Type V	COMMENTS
13.G	Flight phase and content-specific ATC messages, including responses to ownship voice transmissions in appropriate flight phases, to support the intended use. Content of ownship messages in English (as per Doc 4444, *Procedures for Air Navigation Services – Air Traffic Management*). Messages to ownship typical of ATC control. Can be achieved by the instructor providing the ATC simulation.	✓	✓	✓	✓	✓	

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	Type I	Type II	Type III	Type IV	Type V	COMMENTS
13.1	AUTOMATED WEATHER REPORTING						Automated weather reporting provides pilots with essential information about weather conditions and air traffic control operational information. ATIS and other automated weather information may also be provided by datalink to the cockpit. While ATIS is the most common of these automated systems, other automated weather broadcasts, such as ASOS or AWOS, in use at airports or heliports with part-time or no towers should be considered where relevant to the operation.
13.1 S	Multiple station automated weather reporting.						The system should have the capability of generating different automated weather reporting messages providing weather conditions and different other predefined conditions at all airports or heliports in range allowing flight crews to simultaneously listen in to concurrent automated weather reporting messages from different airports or heliports. The instructor should have the ability to override each single value and each predefined message from the instructor station.
13.1 R	Single station automated weather reporting.						At least one automated weather reporting message is required for all airports or heliports in range. The message(s) should consist of the actual weather conditions set in the FSTD including reference airport/heliport, reference runway, temperature, wind, QNH, clouds, visibility, runway conditions as well as predefined other conditions (transition level, etc.), which cannot be read out from the simulation. The instructor should have the ability to change the weather conditions and other predefined conditions for the automated weather reporting message from the instructor station. These instructor inputs need not influence the actual weather conditions of the simulation.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	Type I	Type II	Type III	Type IV	Type V	COMMENTS
13.1 G	Single station automated weather reporting.	✓	✓	✓	✓	✓	At least one automated weather-reporting message is required for all airports or heliports in range. The message(s) should consist of the actual weather conditions set in the FSTD including reference airport/heliport, reference runway, temperature, wind, QNH, clouds, visibility, runway conditions as well as predefined other conditions (transition level, etc.), which cannot be read out from the simulation.
13.2	BACKGROUND CHATTER						
13.2.1 S, R, G	Background chatter (party line). In general all background chatter should meet the following criteria: 1. Communications should make sense within the context of the simulation environment and should not contain obviously erroneous information; 2. Only messages relevant to the purpose of a given frequency should be heard on said frequency; 3. Simulated communications on a given frequency should not step over one another or over communications from the simulator crew; and 4. Reasonable pauses should be provided between communication exchanges to allow the simulator crew access to the frequency when required.	✓	✓	✓	✓	✓	Party line communications simulate background chatter heard in the cockpit e.g. aircraft-to-aircraft, aircraft-to-ground, or ground-to-ground communications other than ownship.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	Type I	Type II	Type III	Type IV	Type V	COMMENTS
13.2.2 S	Content-defined — Location-specific and content-specific messages fully correlated to the visually simulated traffic.						Content-defined background chatter. Background chatter communications simulation should provide party line communications that are tailored to the simulation context, both in form and content. Location-specific procedures and nomenclature should be accurately reflected, and all communications should be fully correlated to the visual representation of the traffic activities. The number of voices should be sufficient to allow differentiation of the various ATC services and pilots. The system should include a minimum of three specific terminal areas. The three specific terminal areas should be part of the approved training programme.
13.2.2 R	Context-defined — Generic messages common to all airports/ heliports correlated to visually simulated traffic.						Context-defined background chatter. Background chatter communications simulation should generate messages with context-specific content based on a generic typical format that would be common to all locations. The background chatter should correlate with the traffic scenario and should not conflict with the ownship position and movements. The communications should also be correlated to the visual representation of the traffic activities. (ctd on next page)

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	Type I	Type II	Type III	Type IV	Type V	COMMENTS
							The number of voices should be sufficient to allow differentiation of the various ATC services and pilots. The system should include a minimum of three specific terminal areas. The three specific terminal areas should be part of the approved training programme.
13.2.2 G	Context-generic — Generic messages with no correlation.	✓	✓	✓	✓	✓	Background chatter communications simulation can be based on generic messages only. Such messages should be defined in such a way that they require no or very little information to be adapted to the simulation context. The voices used need only be diverse enough to avoid confusion between pilots and ATC services.
13.3	ATC SIMULATION — INTERACTION WITH SIMULATOR						Messages received related to ownship position, operational situation and environmental conditions reflecting visual settings and TCAS scenario, if applicable.
13.3 S, R	<u>Simulation Parameters</u> The ATC communication simulation system together with helicopter systems and applicable environment simulation shall provide the following parameters: 1) wind direction/speed/gust; 2) QNH/QFE (altimeter setting); 3) temperature: OAT; 4) dew point; (ctd on next page)						The system should include a minimum of three specific terminal areas. The three specific terminal areas should be part of the approved training programme. Including visual, when applicable.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	Type I	Type II	Type III	Type IV	Type V	COMMENTS
	5) cloud conditions: height and type; 6) visibility; 7) RVR (fog/ground fog/patchy fog); 8) special weather condition set: rain, snow (with wind effects), turbulence, icing, expected wind shear, microburst, and storm clouds/cells with approximate position; 9) active runways; 10) runway condition: contamination and depth of contamination; 11) braking action; 12) UTC; 13) position, track, heading and height of own helicopter; and 14) subject helicopter call sign.						
13.4	ATC SIMULATION — INTERACTION WITH INSTRUCTOR						
13.4 S, R	The instructor should be able to interact with the scenario by injecting messages to the ownship helicopter. When applicable, these messages should be grouped by phase of flight or category as follows: 1) gate: a) dispatch; (ctd on next page)						Regardless of how the ATC simulation is provided, consideration should be given to the workload placed upon the instructor as part of the ATC simulation to ensure it does not significantly distract from the observation of the crew members under training, testing or checking.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	Type I	Type II	Type III	Type IV	Type V	COMMENTS
	b) maintenance;						
	c) departure ATIS;						
	d) route clearance;						
	e) pushback; and						
	f) other routine ATC/company communication;						
	2) de-icing;						
	3) taxi;						
	4) holding position;						
	5) take-off;						
	6) after take-off;						
	7) climb;						
	8) en-route;						
	9) descent;						
	10) arrival ATIS;						
	11) hold;						
	12) approach;						
	13) landing;						
	14) emergency;						
	15) other communication; and						
	16) cabin crew.						

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	Type I	Type II	Type III	Type IV	Type V	COMMENTS
13.5	ATC MESSAGE TRIGGERING						The instructor should be able to trigger messages manually or automatically.
13.5.1 S, R	Manual (basic).						The message is triggered at the instructor's request by an instructor's action from the IOS.
13.5.2 S, R	Automatic (enhanced).						The message is triggered automatically when all the criteria that are relative to the message content (ground or air traffic, phase of flight, weather conditions, etc.) are satisfied. In the event of the ownship not following the ATC instructions, or not following correct readback protocols, the system should provide corrective messages (e.g. ownship not respecting assigned speed, heading or altitude when airborne, or crossing or holding short of assigned runways and taxiways when on the ground).
13.5.3 S, R	The ATC communication simulation system should give to the instructor the ability to pause and/or disable it and return to the classic no-ATC simulation.						
13.6	PHRASEOLOGY						
13.6.1 S, R, G	Phraseology and voice characteristics.	✓	✓	✓	✓	✓	To increase training effectiveness it is of utmost importance that the ATC radio communication simulation should reinforce correct phraseology. The focus should be on achieving 100 per cent realism, to achieve proper situational awareness among the students, during training sessions.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	Type I	Type II	Type III	Type IV	Type V	COMMENTS
13.7	FLIGHT PHASE SPECIFIC ATC FREQUENCY RECOGNITION						
13.7.1 S, R, G	Communications should be appropriate to the radio frequencies set in the cockpit: 1) single-frequency communications;	✓	✓	✓	✓	✓	Flight phase specific ATC frequency recognition, a requirement for all levels of ATC simulation, means that all communications received by the pilot should be appropriate to the radio frequencies set in the cockpit.
	2) multiple-frequency communications.	✓	✓	✓	✓	✓	Example: the pilot listening to ATIS on VHF 1 while the co-pilot waits for clearance delivery on VHF 2.
13.7.2 S, R, G	The simulated environment should be kept updated in conjunction with other system updates with regard to company or ATC radio frequency changes.	✓	✓	✓	✓	✓	The facility to use company radio frequencies should be available, but these should not necessarily be linked to "real world" company radio frequencies, providing this does not cause a conflict with existing ATC frequencies.
13.8	INSTRUCTOR CONTROL OVER OTHER TRAFFIC						
13.8.1 S, R, G	Instructor control over other traffic. Instructor should have the ability to control other traffic.	✓	✓	✓	✓	✓	Examples of instructor control of other traffic: 1) priority for ownship for take-off, landing and ground, hover and air manoeuvres with respect to other traffic; 2) another aircraft in the scenario to have an emergency or to obstruct ownship helicopter; 3) levels of traffic activity in the scenario; and 4) restrictions on speed for an approaching aircraft.
13.8.2 S, R	Correlation. Communications should be consistent with other ground and air traffic representations in the simulation and helicopter systems (TCAS).						Air traffic control communications should be consistent with other dynamic ground and air traffic movements, including those influenced by traffic conflicts and subject aircraft priority issues. Traffic information displayed by both visual and onboard systems should be consistent with TCAS.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	Type I	Type II	Type III	Type IV	Type V	COMMENTS
13.8.3 S, R	Traffic flow. Unless otherwise selected by the instructor, airport/heliport traffic flow should be representative of flow density for the time of day at the modelled airport/heliport. Representative traffic separation times should be respected.						Examples of appropriate traffic flows for a major airport/heliport: <u>Light</u>: 1 to 15 take-offs and/or landings per hour or less than 20 total movements per hour. <u>Medium</u>: 16 to 50 take-offs and/or landings per hour or 70 total movements per hour. <u>Heavy</u>: 51 or more take-offs and/or landings per hour or greater than 100 total movements per hour.
13.9	DATALINK COMMUNICATIONS						
13.9.1 S	ACARS / ATN.						If installed.
13.9.2 S	FANS.						If installed.
13.9.3 S	OTHER.						If installed.

14. REQUIREMENT — MISCELLANEOUS

14.	FEATURE GENERAL REQUIREMENT Miscellaneous	Type I	Type II	Type III	Type IV	Type V	COMMENTS
14.S	N/A.						This “miscellaneous” feature is defined in Part I, 6.1.14, is not directly related to the training perspective and is thus not included in the FSTD Summary Matrix of Part II, Chapter 2. Therefore, “N/A” is shown for the three listed fidelity levels. However, the relevant items of this feature have tests described in the rest of this paragraph.
14.R	N/A.						
14.G	N/A.						

14	FEATURE TECHNICAL REQUIREMENT Miscellaneous	Type I	Type II	Type III	Type IV	Type V	COMMENTS
14.1	INSTRUCTOR OPERATING STATION						
14.1 S	The instructor operating station should provide an adequate view of the pilots' panels and forward windows.			✓	✓	✓	For an FSTD with a motion cueing system, any on board instructor seat should be adequately secured and fitted with positive restraint devices of sufficient integrity to safely restrain the occupant during any known or predicted motion system excursion. If an EFVS is installed, the instructor operating station should include an EFVS display repeater of the EFVS being simulated, as seen through the pilot's HUD or the cockpit displays. This includes any displayed data and symbology. The display format (aspect ratio) should be replicated.
14.1 R	The instructor operating station should provide an adequate view of the pilots' panels and forward windows.	✓	✓				
14.1 G	N/A.						
14.2	INSTRUCTOR CONTROLS						
14.2 S, R, G	The instructor operating station should have controls that enable the instructor to control all required system variables and insert all abnormal or emergency conditions into the simulated helicopter systems, as appropriate. The instructor operating station should have controls for all environmental effects expected to be available at the instructor operating station (e.g. clouds, visibility, icing, precipitation, temperature, storm cells, and wind speed and direction). (ctd on next page)	✓	✓	✓	✓	✓	

14	FEATURE TECHNICAL REQUIREMENT Miscellaneous	Type I	Type II	Type III	Type IV	Type V	COMMENTS
	The instructor operating station should provide to the instructor the ability to present ground and air hazards. It should provide to the instructor the ability to present the effect of re-circulating dust, water vapour, or snow conditions that develop as a result of rotor downwash.						
14.3	SELF–DIAGNOSTIC TESTING						
14.3 S	Self-diagnostic testing of the FSTD should be available to determine the integrity of hardware and software operation and to provide a means for quickly and effectively conducting daily testing of the FSTD software and hardware.			✓	✓	✓	An SOC is required.
14.3 R, G	N/A.						
14.4	COMPUTER CAPACITY						
14.4 S, R, G	Sufficient FSTD computer capacity, accuracy, resolution and dynamic response should be provided to fully support the overall FSTD fidelity needed to meet the qualification type sought.	✓	✓	✓	✓	✓	An SOC is required.
14.5	AUTOMATIC TESTING FACILITIES						
14.5 S	Automatic QTG/validation testing of FSTD hardware and software to determine compliance with the validation requirements should be available.			✓	✓	✓	Evidence of testing should include test identification, FSTD number, date, time, conditions, tolerances, and the appropriate dependent variables portrayed in comparison with the helicopter standard.
14.5 R, G	Validation testing of FSTD hardware and software to enable recurrent testing should be available.	✓	✓				Evidence of testing should include test identification, FSTD number, date, time, conditions, tolerances, and the appropriate dependent variables portrayed in comparison with the Master QTG test standard. Automatic QTG validation/testing is encouraged.

14	FEATURE TECHNICAL REQUIREMENT Miscellaneous	Type I	Type II	Type III	Type IV	Type V	COMMENTS
14.6	UPDATES TO FSTD HARDWARE AND SOFTWARE						
14.6 S, R	Timely permanent update of FSTD hardware and software should be conducted subsequent to helicopter modification where it affects training, sufficient for the qualification type sought.	✓	✓	✓	✓	✓	
14.6 G	Timely permanent update of FSTD hardware and software should be conducted subsequent to FSTD manufacturer recommendation where it affects training and/or safety.						
14.7	DAILY PRE-FLIGHT DOCUMENTATION						
14.7 S, R, G	Daily pre-flight documentation either in the daily log or in a location easily accessible for review is required.	✓	✓	✓	✓	✓	
14.8	SYSTEM INTEGRATION						
14.8	System Integration Relative response of the visual system, cockpit instruments and initial motion system coupled closely to provide integrated sensory cues. Visual scene changes from steady state disturbance (i.e. the start of the scan of the first video field containing different information) should occur within the system dynamic response limit of 85 or 120 milliseconds (ms) depending on the FSTD type. Motion onset should also occur within the system dynamic response limit of 85 or 120 ms depending on the FSTD type. While motion onset should occur before the start of the scan of the first video field containing different information, it needs to occur before the end of the scan of the same video field.						A test is required. See Part II, Appendix B (test 6.a, transport delay). A latency test may be used as an alternate means of compliance in place of the transport delay test. Attachment G provides guidance for transport delay and latency test methodologies.

14	FEATURE TECHNICAL REQUIREMENT Miscellaneous	Type I	Type II	Type III	Type IV	Type V	COMMENTS
	The test to determine compliance with these requirements should include simultaneously recording the output from the pilot's pitch, roll and yaw controllers, the output from the accelerometer attached to the motion system platform located at an acceptable location near the pilots' seats, the output signal to the visual system display (including visual system analogue delays) and the output signal to the pilot's attitude indicator or an equivalent test approved by the NAA.						
14.8.S	Transport delay: A transport delay test should be used to demonstrate that the FSTD system response does not exceed 85 ms. Where EFVS systems are installed, they should respond within + or - 30 ms from the visual system, and not before the motion response.			✓	✓	✓	Results required for instruments, motion and visual systems. Additional transport delay test results are required where HUD systems are installed, which are simulated and not actual helicopter systems. Where a visual system's mode of operation (daylight, twilight and night) can affect performance, additional tests are required. An SOC is required where the visual system's mode of operation does not affect performance, precluding the need to submit additional tests.
14.8. R, G	Transport delay: A transport delay test should be used to demonstrate that the FSTD system response does not exceed 120 ms.	✓	✓				Results required for applicable systems only.

14	FEATURE TECHNICAL REQUIREMENT Miscellaneous	Type I	Type II	Type III	Type IV	Type V	COMMENTS
14.9	RECORD, FREEZE AND PLAYBACK						
14.9 S, R, G	Record, freeze and playback capability.	✓	✓	✓	✓	✓	
14.10	BRIEFING AND DEBRIEFING						
14.10 S, R, G	Briefing and debriefing capability.	✓	✓	✓	✓	✓	

Appendix B

FSTD VALIDATION TESTS

1. INTRODUCTION

1.1 FSTD performance and system operation should be objectively evaluated by comparing the results of tests conducted in the FSTD to validation data, unless specifically noted otherwise. The validation, functions and subjective tests required for the QTG enable the evaluator to "spot check" the performance of the FSTD in order to confirm that it represents the helicopter in some significant training or testing and checking areas. Without such "spot checking", using the QTG, FSTD performance could not be verified in the time normally available for the regulatory evaluation. It should be clearly understood that the QTG does not provide a rigorous examination of the quality of the simulation in all areas of flight and systems operation. The full testing of the FSTD simulation is intended to have been completed by the FSTD manufacturer's and the operator's personnel prior to the FSTD being submitted for the regulatory evaluation and prior to the delivery of the results in the QTG. This "in depth" testing is a fundamental part of the whole cycle of testing and is normally carried out using documented acceptance test procedures in which the test results are recorded. These procedures will test the functionality and performance of many areas of the simulation that are not addressed in the QTG as well as such items as the Instructor Operating Station, etc. To facilitate the validation of the FSTD using the QTG, an appropriate recording device acceptable to the authority should be used to record each validation test result. These recordings should then be compared to the validation data. The QTG validation tests should be documented, considering the following:

a) the FSTD QTG should describe clearly and distinctly how the FSTD will be set up and operated for each test. Use of a driver programme designed to automatically accomplish the tests is strongly recommended when practical. It is not the intent, nor is it acceptable, to test each FSTD sub-system independently. Overall integrated testing of the FSTD, with test inputs at the pilot controls, should be accomplished to assure that the total FSTD system meets the prescribed standards;

b) to ensure compliance with this intent, QTGs should contain explanatory material which clearly indicates how each test (or group of tests) is executed, e.g. which parameters are driven/free/constrained and the use of closed/open loop drivers; and

c) all QTG validation tests based on flight test data should also be able to be run manually in order to validate the automatic test results. Short-term tests with simple inputs should be easily reproduced manually. Longer term tests with complex inputs are unlikely to be easily duplicated.

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

1.3 A manual test procedure with explicit and detailed steps for completion of each test should also be provided. The function of the manual test procedure is to confirm that the results obtained when using an automated driver are the same as those that would be experienced by a pilot flying the same test and using the same control inputs as were used by the pilot in the helicopter from which the validation flight test data were recorded. The manual test results should be able to be achieved using the same tolerances as those utilized for the automatic test. Manual test results may not meet the tolerances; however the NAA inspector should be confident they could meet the tolerances if enough effort was spent trying to reproduce the pilot inputs exactly.

1.4 Submission for approval of data other than flight test should include an explanation of validity with respect to available flight test information. Tests and tolerances in this appendix should be included in the FSTD QTG. The QTG should be supported by a validation data roadmap (VDR) as described in Attachment D to this Part. Data providers are encouraged to supply a VDR for helicopters type certificated prior to 1 January 2012.

1.5 The table of FSTD validation tests in this appendix indicates the required tests. Unless noted otherwise, FSTD tests should represent helicopter performance and handling qualities at operating mass and centre of gravity (CG) positions typical of normal operation. If a test is supported by helicopter data at one extreme mass or CG position, another test supported by helicopter data at mid-conditions or as close as possible to the other extreme should be included. Certain tests which are relevant only at one extreme mass or CG position need not be repeated at the other extreme. Tests of handling qualities should include validation of augmentation devices.

1.6 For the testing of computer-controlled helicopter (CCH) FSTDs, flight test data are required for both the normal (N) and non-normal (NN) control states, as indicated in the validation requirements of this appendix. Tests in the non-normal state will always include the least augmented state. Tests for other levels of control state degradation may be required as detailed by the NAA at the time of definition of a set of specific helicopter tests for FSTD data. Where applicable, flight test data should record pilot controller deflections or electronically generated inputs including location of input.

1.7 The recording requirements of 1.6 apply to both normal and non-normal states. All tests in the table of FSTD validation tests require test results in the normal control state unless specifically noted otherwise in the comments section following the CCH designation. However, if the test results are independent of control state, non-normal control data may be substituted.

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

1.9 Tests affected by normal, non-normal or other degraded control states not possible in the approved operating envelope of the helicopter being simulated, and for which results cannot be provided, should be addressed in the QTG by an appropriate rationale included from the helicopter manufacturer's VDR.

2. TEST REQUIREMENTS

2.1 The ground and flight tests required for qualification are listed in the table of FSTD validation tests. Computer-generated FSTD test results should be provided for each test. The results should be produced on an appropriate recording device acceptable to the NAA. Time histories are required unless otherwise indicated in the table of FSTD validation tests.

2.2 In those cases where the objective test results authorize a "snapshot test" or a "series of snapshot tests" in lieu of a time history, the data provider should ensure that a steady state condition exists at the instant of time captured by the "snapshot." This is often verified by showing that a steady state condition existed from some period prior to, through some period following, the snapshot. The time period most frequently used is from 5 seconds prior to, through 2 seconds following, the instant of time captured by the snapshot. Since helicopter data are often oscillatory about a trim condition, an alternate method of defining snapshot target parameters is to select a time window lasting approximately 5 seconds during which the time-average of relevant recorded parameters is taken as the target trim condition. This paragraph is primarily addressing the validation data and the method by which the data provider ensures that the steady state condition for the snapshot is representative. The snapshot definition in the glossary as an instant in time still applies to FSTD results.

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

2.4 *Parameters, tolerances and flight conditions*. The table of FSTD validation tests describes the parameters, tolerances and flight conditions for FSTD validation. When two tolerance values are given for a parameter, the less restrictive may be used unless indicated otherwise. Regardless, the test should exhibit correct trends. FSTD results should be labelled using the tolerances and units given, considering the following:

a) the tolerances for some of the objective tests have been reduced to “Correct Trend and Magnitude” (CT&M). 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 simulated designated helicopter and should under no circumstances exhibit characteristics that could lead to negative training;

b) the tolerances listed for tests noted as CT&M are applicable for recurrent evaluations and should be applied to ensure the device remains at the standard initially qualified. Where CT&M is noted, it is required that an automatic recording system be used to “footprint” the baseline results thereby avoiding the effects of possible divergent subjective opinions during recurrent evaluations;

c) for parameters normally observed in units of per cent (e.g. torque, N_g, or N_p), or when a tolerance is given only in units of per cent, the tolerance should be applied as an absolute tolerance on the normal operating range of the parameter measured from its zero value (i.e. for an observation of 50 per cent torque and a tolerance of 3 per cent, the acceptable range would be from 47 per cent to 53 per cent) The per cent tolerance should be applied to the following parameters throughout the Table of Validation Tests except where otherwise noted:

   1) *rotor speed*: absolute percentage of 100 per cent indication, or of nominal operating RPM if cockpit display is not in units of per cent;

   2) *power turbine speed*: absolute percentage of 100 per cent indication, or of nominal operating RPM if cockpit display is not in units of per cent;

   3) *gas generator speed*: absolute percentage of 100 per cent indication, or of single-engine maximum continuous gas generator speed if cockpit display is not in units of per cent;

   4) *torque*: absolute percentage of 100 per cent indication, or of single-engine maximum continuous torque if cockpit display is not in units of per cent;

   5) *longitudinal control position*: absolute percentage of full travel;

   6) *lateral control position*: absolute percentage of full travel;

   7) *collective control position*: absolute percentage of full travel; and

   8) *directional control position*: absolute percentage of full travel.

d) for parameters not displayed in units of per cent and that are not listed in paragraph 2.4 c) above, a tolerance expressed only as a percentage will be interpreted as the percentage of the current reference value of that parameter during the test, except for parameters varying around a zero value for which a minimum absolute value should be agreed with the NAA;

e) when a tolerance is stated as both a per cent and an absolute value, the per cent tolerance is interpreted as the percentage of the instantaneous reference value of that parameter. The less restrictive of the tolerances may be used. This interpretation applies to all parameters not listed in paragraph 2.4 c) above; and

f) for the conditions where the design of the flight controls system does not imply any difference on the rotor blade pitch positions between augmented case and unaugmented case, unaugmented case validation data are not required for the unaugmented case. A rationale is to be provided to identify which tests are not performed.

2.5 *Flight condition verification*. When comparing the parameters listed to those of the helicopter, sufficient data should also be provided to verify the correct flight condition. For example, to show the control force is within ± 0.222 daN (0.5 lbf) in a static stability test, data to show correct airspeed, power or torque, helicopter configuration, altitude, and other appropriate datum identification parameters should also be given. If comparing short-term response, normal acceleration may be used to establish a match to the helicopter, but airspeed, altitude, control input, helicopter configuration and other appropriate data should also be given. All airspeed values should be clearly annotated as to indicated, calibrated, etc., and like values used for comparison.

2.6 *Flight condition definitions*. The flight conditions specified in the table of FSTD validation tests, tests 1 (Performance) and 2 (Handling Qualities) (and occasionally in other tests) are defined as follows:

a) ground — on ground;

b) lift-off — gear down, transition from the on ground to the hover;

c) take-off — gear down, if applicable;

d) hover in ground effect (IGE) — gear down, if applicable;

e) hover out of ground effect (OGE) — gear up, if applicable;

f) hover — gear up or down, if applicable;

g) climb/descent — gear up, if applicable, at normal climb/descent speeds;

h) autorotation — gear up or down, if applicable, at autorotation speed;

i) clean — gear up, if applicable;

j) cruise — clean configuration at cruise altitude and airspeed;

k) approach — gear up or down, if applicable, at normal approach speed;

l) landing — gear down, if applicable, till the hover position in ground effect; and

m) touchdown — gear down (if applicable) from the hover to the ground contact.

2.7 *Relative wind (on ground, take-off, landing and hover tests).* If relevant winds are present in the objective data, the wind vector (magnitude and direction) should be clearly noted as part of the data presentation, expressed in conventional terminology, and related to the runway being used for the test.

3. INFORMATION FOR VALIDATION TESTS

3.1 Reserved

3.2 Control dynamics

3.2.1 *General*. 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 flight controls. Considerable effort is expended on helicopter feel system design so that pilots will be comfortable and will consider the helicopter desirable to fly. In order for an FSTD to be representative, it too should present the pilot with the proper feel: that of the helicopter being simulated. Compliance with this requirement should be determined by comparing a recording of the control feel dynamics of the FSTD to actual helicopter measurements in the take-off, cruise and landing configurations.

3.2.1.1 Recordings such as free response to a pulse or step function are traditionally used to estimate the dynamic properties of electromechanical systems. In any case, the dynamic properties can only be estimated since the true inputs and responses are also only estimated. Therefore, it is imperative that the best possible data be collected since close matching of the FSTD control loading system to the helicopter systems is essential. The required control dynamics tests are indicated in 2.a.5 of the table of FSTD validation tests.

3.2.1.2 Control dynamics characteristics are usually assessed by measuring the free response of the controls using a step input or pulse input to excite the system. The procedure should be accomplished in the take-off, cruise and landing flight conditions and configurations.

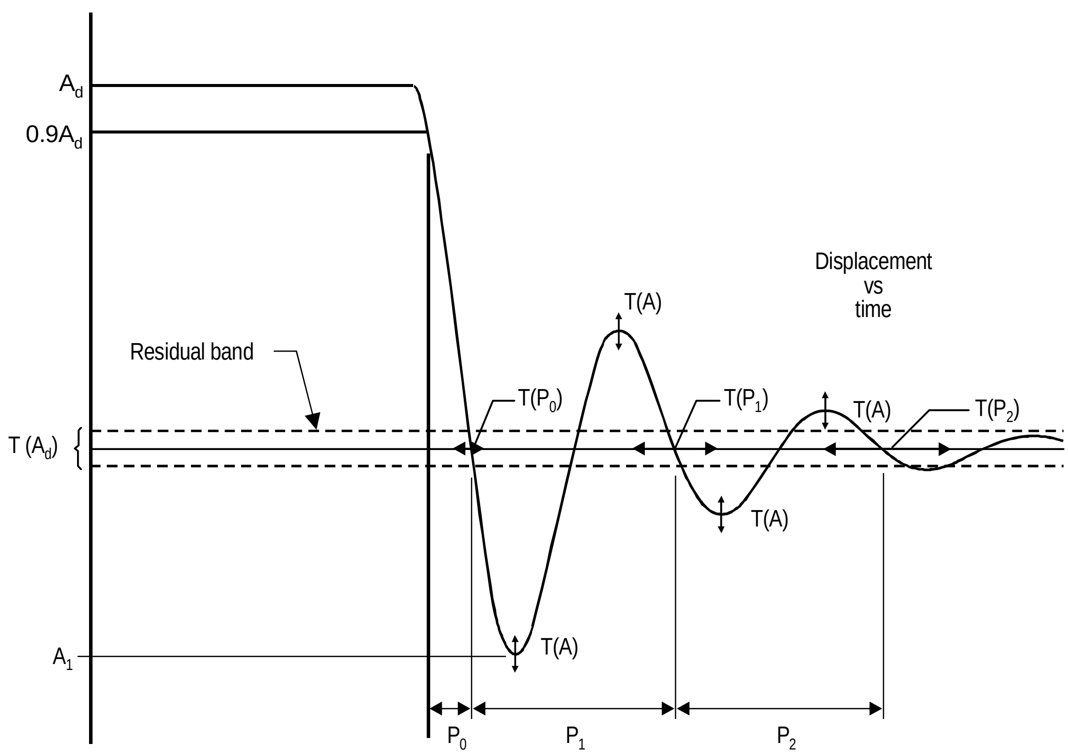
3.2.1.3 For helicopters with irreversible control systems, measurements may be obtained on the ground if proper pitot-static inputs are provided to represent airspeeds typical of those encountered in flight. Likewise, it may be shown that for some helicopters, take-off, cruise and landing configurations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

3.2.2 *Control dynamics evaluation.* The dynamic properties of control systems are often stated in terms of frequency, damping and a number of other traditional measurements which can be found in various documents available on control systems. In order to establish a consistent means of validating test results for FSTD control loading, criteria are needed that will clearly define the interpretation of the measurements and the tolerances to be applied. Criteria are needed for underdamped, critically damped and overdamped systems. In the case of an underdamped system with very light damping, the system may be quantified in terms of frequency and damping. In critically damped or overdamped systems, the frequency and damping are not readily measured from a response time history. Therefore, some other measurement should be used.

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

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

The damping tolerance should be applied to overshoots on an individual basis. Care should be taken when applying the tolerance to small overshoots since the significance of such overshoots becomes questionable. Only those overshoots larger than 5 per cent of the total initial displacement should be considered. The residual band, labelled $T(A_d)$ on Figure B-1 is ± 5 per cent of the initial displacement amplitude A_d from the steady state value of the oscillation, or ± 0.5 per cent of the total control travel (stop to stop). Only oscillations outside the residual band are considered significant. When comparing FSTD data to helicopter data, the process should begin by overlaying or aligning the FSTD and helicopter displacement values and then comparing amplitudes of oscillation peaks, the time to the first zero crossing and individual periods of oscillation. The FSTD should show the same number of significant overshoots to within one when compared against the helicopter data. This procedure for evaluating the response is illustrated in Figure B-1.



P = Period
A = Amplitude
T(P) = Tolerance applied to period (10% of P_0, 10 (n + 1) % of P_n)
T(A) = Tolerance applied to amplitude (0.1 A_1)

Figure B-1. Underdamped step response

b) *Critically damped and overdamped response*. Due to the nature of critically damped and overdamped responses (no overshoots), the time to travel from 90 per cent of the initial displacement to 10 per cent of the steady state (neutral point) value should be the same as the helicopter within ± 10 per cent or ± 0.05 s. Figure B-2 illustrates the procedure.

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

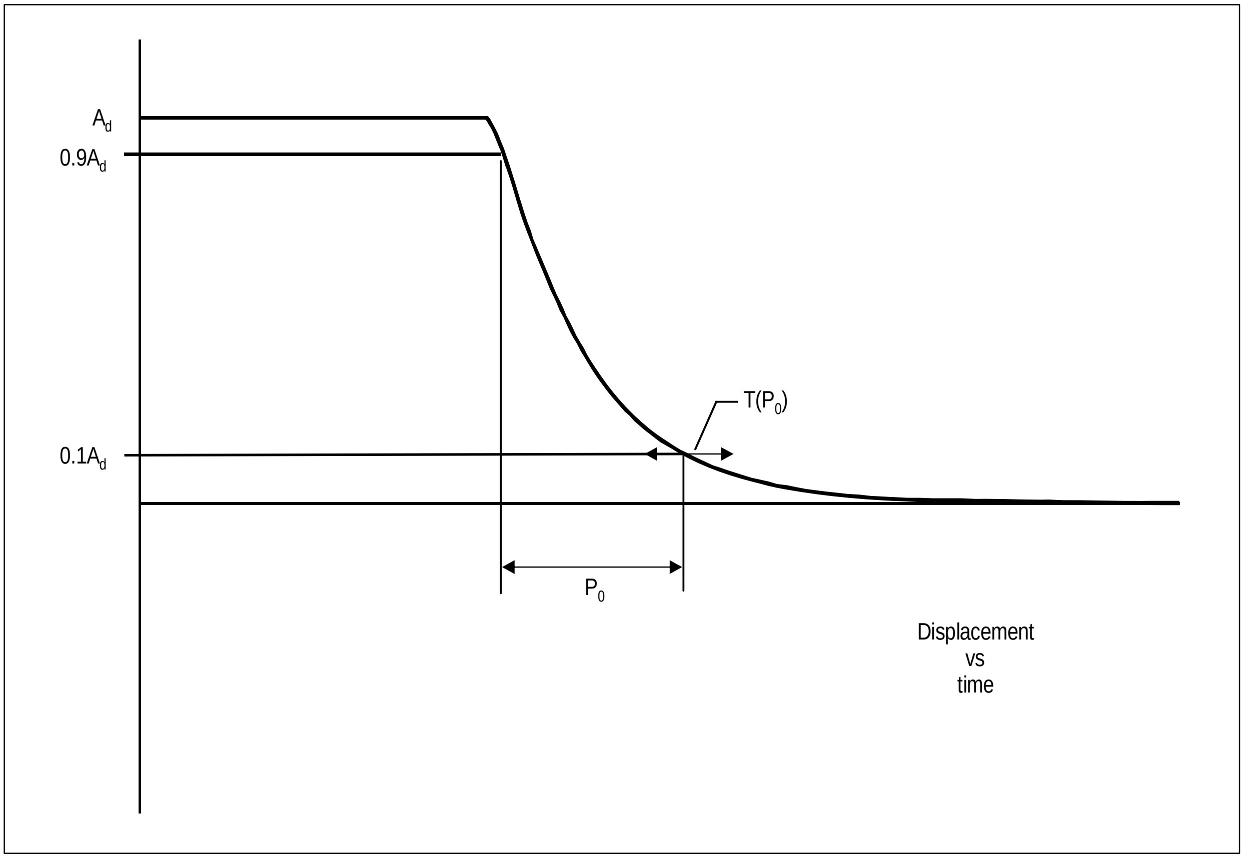


Figure B-2. Critically damped step response

3.2.2.2 *Tolerances.* The following table summarizes the tolerances, T for underdamped systems. See Figure B-1 for an illustration of the referenced measurements.

$T(P_0)$	± 10 per cent of P_0 or ± 0.05 s.
$T(P_1)$	± 20 per cent of P_1 or ± 0.05 s.
$T(P_2)$	± 30 per cent of P_2 or ± 0.05 s.
$T(P_n)$	± 10*(n+1) per cent of P_n or ± 0.05 s.
$T(A_n)$	± 10 per cent of A_{max}, where A_{max} is the largest amplitude or ± 0.5 per cent of the total control travel (stop to stop).
$T(A_d)$	± 5 per cent of A_d = residual band or ± 0.5 per cent of the maximum control travel = residual band.

± 1 significant overshoots (minimum of 1 significant overshoot).
Steady state position within residual band.

Note 1.— Tolerances should not be applied on period or amplitude after the last significant overshoot.

Note 2.— Oscillations within the residual band are not considered significant and are not subject to tolerances.

The following tolerance applies to the overdamped and critically damped systems only. See Figure B-2 for an illustration of the reference measurement.

$T(P_0)$ ± 10 per cent of P_0 or ± 0.05 s.

3.2.3 *Alternate method for control dynamics evaluation of irreversible flight controls*. One helicopter manufacturer has proposed, and its NAA 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.

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

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; and

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 lbf) or as limited by the helicopter control system.

3.2.3.2 *Tolerances*.

a) *Static test*. Items 2.a.1, 2.a.2 and 2.a.3 of the table of FSTD validation tests; and

b) *Dynamic test*. ± 0.9 daN (2 lbf) or ± 10 per cent of dynamic increment above static test.

3.2.3.3 Authorities are open to alternative means such as the one described in 3.2.3. 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 NAA find that alternative methods do not result in satisfactory performance, more conventionally accepted methods should then be used.

3.2.4 *Alternate method for control dynamics evaluation of flight controls with atypical response*. Dynamic responses exhibiting atypical behaviour, as frequently seen on reversible controls, may be evaluated using an alternate reference line better suited for such cases. This alternate line is based on the dynamic response itself and attempts to better approximate the true rest position of the control throughout the step response. A full discussion on how to compute the alternate reference line is provided in Attachment N to this Part. Figure B-3 shows the final result, and how to apply the tolerances using the new reference.

3.2.5 A flight control dynamic response is considered atypical when it does not exhibit classic second order system behaviour. For underdamped systems, the key features of such a behaviour are: a constant period, decaying overshoots (an overshoot is always smaller than the previous one) and a fixed steady state position. Overdamped systems show a control position that will demonstrate a smooth exponential decay from its initial displacement towards a fixed steady state position.

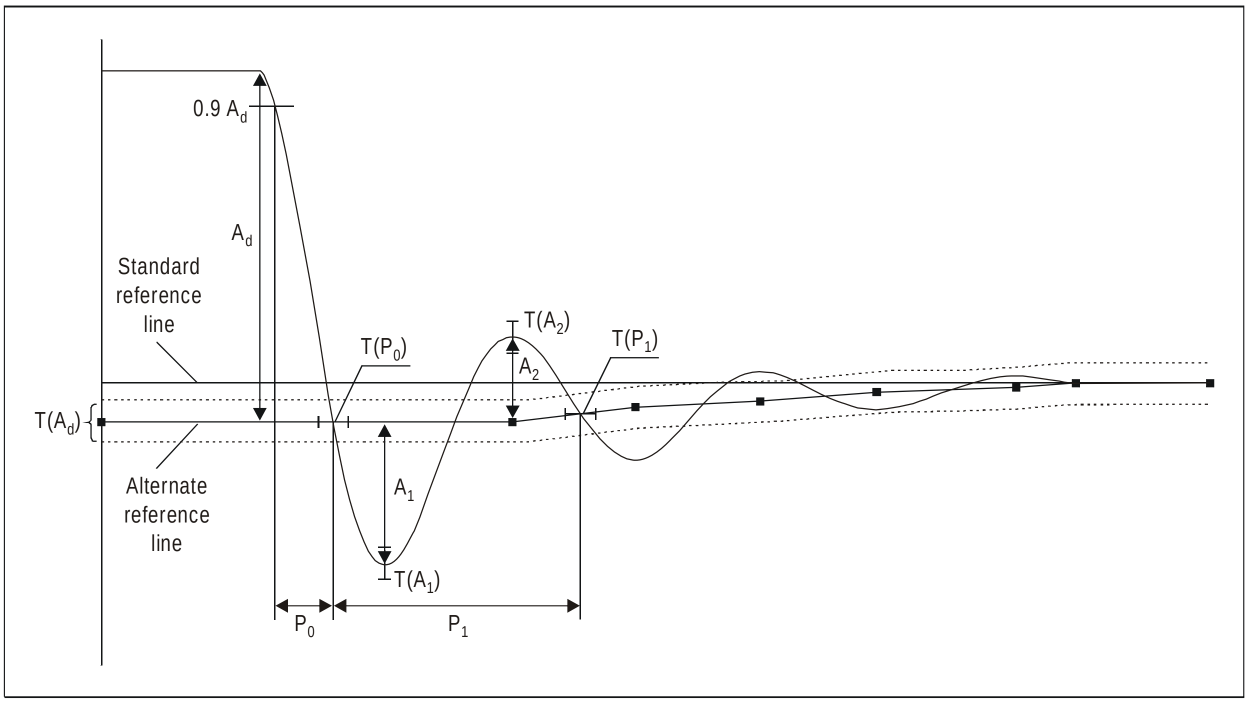


Figure B-3. Tolerances applied using the alternate reference line

3.3 Ground effect

An FSTD to be used for lift-off and touchdown should faithfully reproduce the aerodynamic changes which occur in ground effect. There are no specific tests for ground effect as it is considered to be fully evaluated during the air taxi test, if applicable, and more specifically during the lift-off to hover, hover performance, and low-speed handling qualities tests. The parameters chosen for FSTD validation should 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 to maintain height;

c) height;

d) airspeed;

e) pitch attitude; and

f) roll attitude.

3.4 Engineering simulation validation data

3.4.1 When a fully flight-test validated simulation is modified as a result of changes to the simulated helicopter configuration, a qualified helicopter manufacturer may, with the prior agreement of the relevant NAA:

a) supply validation data from an audited engineering simulator/simulation to selectively supplement flight test data. This arrangement is confined to changes that are incremental in nature and which are both easily understood and well defined; and

b) support the most recent data package using engineering simulator validation data, and track only the latest version of test requirements.

When the operator receives appropriate validation data from the approved data provider and receives approval from the NAA, the operator may adopt tests and associated tolerances described in the current qualification standards as the tests and tolerances applicable for the continuing qualification of a previously qualified FSTD. The updated test(s) and tolerance(s) should be made a permanent part of the MQTG.

3.4.2 To be qualified to supply engineering simulator validation data, a helicopter manufacturer, or other approved data supplier, should:

a) have a proven track record of developing successful data packages;

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

c) have an engineering simulator that:

1) has models which run in an integrated manner;

2) uses the same models as those released to the training community (which are also used to produce stand-alone proof-of-match and check-out documents); and

3) is used to support helicopter development and certification;

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

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

3.4.3 Helicopter manufacturers seeking to take advantage of this alternative arrangement should contact the NAA at the earliest opportunity.

3.4.4 For the initial application, each applicant should demonstrate its ability to qualify to the satisfaction of the NAA, in accordance with the means provided in this appendix and Attachment B to this Part.

3.5 Motion system

3.5.1 *General*

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

3.5.1.2 The objective validation tests presented in this appendix are intended to qualify the FSTD motion cueing system from both a mechanical performance standpoint, as well as from a motion cueing fidelity perspective.

3.5.2 *Motion system checks*. The intent of tests as described in the table of FSTD validation tests, 3.a – Frequency response and 3.b – Turnaround check, is to demonstrate the performance of the motion system hardware and to check the integrity of the motion set-up with regard to calibration and wear. These tests are independent of the motion cueing software and should be considered as robotic tests.

3.5.3 *Frequency response*. The test must demonstrate the frequency response of the motion system.

3.5.4 *Turnaround check*. The test must demonstrate a smooth turnaround (shift to opposite direction of movement) of the motion system as specified by the applicant for FSTD qualification.

3.5.5 *Motion system repeatability*. The intent of this test is to ensure that the motion system software and motion system hardware have not degraded or changed over time. This will allow an improved ability to determine changes that have adversely affected the training value of the motion as was accepted during the initial qualification. The following information delineates the methodology that should be used for this test:

a) Conditions:

1) one test case on-ground: to be determined by the operator; and

2) one test case in-flight: to be determined by the operator.

b) Input. The inputs should be such that both rotational accelerations/rates and linear accelerations are inserted before the transfer from helicopter CG to pilot reference point with a minimum amplitude of $5°/s^2$, 10°/s and 0.3 g, respectively, to provide adequate analysis of the output.

c) Recommended output:

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

2) motion actuators position.

With the same input signal, the test results must be repeatable to within ± 0.05 g of the actual platform linear acceleration in each axis.

3.5.6 *Motion cueing fidelity tests*

3.5.6.1 Frequency-domain based objective motion cueing test

3.5.6.1.1 Background. Attachment F to this Part contains a full description of the frequency-domain based objective motion cueing test. This test quantifies the response of the motion cueing system from the output of the flight model to the motion platform response. Other motion tests, such as the motion system frequency response, concentrate on the mechanical performance of the motion system hardware alone. The intent of this test is to provide quantitative frequency response records of the entire motion system for specified degree-of-freedom transfer relationships over a range of frequencies. This range should be representative of the manual control range for that particular aircraft type and the FSTD as set up during qualification. The measurements of this test should include the combined influence of the motion cueing algorithm, the motion platform dynamics, and the transport delay associated with the motion cueing and control system implementation. Specified frequency responses describing the ability of the FSTD to reproduce aircraft translations and rotations, as well as the cross-coupling relations, are required as part of these measurements. When simulating forward aircraft acceleration, the FSTD is also accelerated momentarily in the forward direction to provide the onset cueing. This is considered the direct transfer relation. The FSTD is simultaneously tilted nose-up due to the low-pass filter in order to generate a sustained specific force. The tilt associated with the generation of the sustained specific force, and the angular rates and angular accelerations associated with the initiation of the sustained specific force, are considered cross-coupling relations. The specific force is required for the perception of the aircraft sustained specific force, while the angular rates and accelerations do not occur in the aircraft and should be minimized.

3.5.6.1.2 List of tests. These tests require the frequency response to be measured for the motion cueing system. Reference sinusoidal signals are inserted at the pilot reference position prior to the motion cueing computations. The response of the motion platform in the corresponding degree-of-freedom (the direct transfer relations), as well as the motions resulting from cross-coupling (the cross-coupling relations), are recorded. These are given in Table B-1. These are the tests that are important to pilot motion cueing and are general tests applicable to all types of helicopters. These tests can be run at any time deemed acceptable to the NAA prior to and/or during the qualification.

Table B-1. Motion cueing system transfer test matrix

	FSTD Response Output					
Aircraft Input Signal	Pitch	Roll	Yaw	Surge	Sway	Heave
Pitch	1			2		
Roll		3			4	
Yaw			5			
Surge	7			6		
Sway		9			8	
Heave						10

The relations are explained below per individual test in Table B-1:

1) FSTD pitch response to aircraft pitch input;

2) FSTD surge translation response due to aircraft pitch input;

3) FSTD roll response to aircraft roll input;

4) FSTD sway translation response due to aircraft roll input;

5) FSTD yaw response to aircraft yaw input;

6) FSTD surge response to aircraft surge input;

7) FSTD pitch rate and pitch acceleration response to aircraft surge input;

8) FSTD sway response to aircraft sway input;

9) FSTD roll rate and pitch acceleration response to aircraft sway input; and

10) FSTD heave response to aircraft heave input.

Tests 1, 3, 5, 6, 8 and 10 show the direct transfer relations, while tests 2, 4, 7 and 9 show the cross-coupling relations.

3.5.6.1.3 Frequencies. The tests should be conducted by introducing sinusoidal inputs at discrete input frequencies entered at the output of the flight model, transformed to the pilot reference position just before the motion cueing computations, and measured at the response of the FSTD platform. The frequencies for these tests are given in Table B-2. The relationship between the frequency and corresponding modulus and phase defines the system transfer function. This test requires that, for each degree-of-freedom, measurements at 12 frequencies should be taken.

Table B-2. Recommended test input signal frequencies and required measured outputs (modulus and phase) for each test shown in Table B-1.

Frequency signal number	*Frequency [rad/s]*	*Frequency [Hertz]*	*Modulus [non-dimensional]*	*Phase [°]*
1	0.100	0.0159 Hz		
2	0.158	0.0251 Hz		
3	0.251	0.0399 Hz		
4	0.398	0.0633 Hz		
5	0.631	0.1004 Hz		
6	1.000	0.1591 Hz		
7	1.585	0.251 Hz		
8	2.512	0.399 Hz		
9	3.981	0.633 Hz		
10	6.310	1.004 Hz		
11	10.000	1.591 Hz		
12	15.849	2.515 Hz		

3.5.6.1.4 Input signal amplitudes. The tests applied here to the motion cueing system are intended to qualify its response to normal control inputs during manoeuvring (i.e. not aggressive or excessively hard control inputs). It is necessary to excite the system in such a manner that the response is measured with a high signal-to-noise ratio, and that the possible non-linear elements in the motion cueing system are not overly excited. The sinusoidal input signal amplitudes are defined in Tables B-3 and B-4.

3.5.6.1.5 Data recording. The measured parameters for each test should include the modulus and phase as prescribed in Table B-2 for the tests delineated in Table B-1. The modulus indicates the absolute value of the amplitude ratio of the output signal divided by the input signal, expressed in non-dimensional terms. The phase describes the delay at that frequency between the output signal and the input signal, and is expressed in degrees.

Table B-3. Linear accelerations input signal amplitude

Frequency signal number	*Frequency [rad/s]*	*Frequency [Hz]*	*Acceleration amplitude [m/s^2]*
1	0.100	0.0159 Hz	1.00
2	0.158	0.0251 Hz	1.00
3	0.251	0.0399 Hz	1.00
4	0.398	0.0633 Hz	1.00
5	0.631	0.1004 Hz	1.00

Frequency signal number	*Frequency [rad/s]*	*Frequency [Hz]*	*Acceleration amplitude [m/s²]*
6	1.000	0.1591 Hz	1.00
7	1.585	0.251 Hz	1.00
8	2.512	0. 399 Hz	1.00
9	3.981	0.633 Hz	1.00
10	6.310	1.004 Hz	1.00
11	10.000	1.591 Hz	1.00
12	15.849	2.515 Hz	1.00

Table B-4. Rotational amplitudes limited by attitude, angular rate or acceleration

Frequency signal number	*Frequency [rad/s]*	*Frequency [Hz]*	*Attitude amplitude [°]*	*Angular rate amplitude [°/s]*	*Angular acceleration amplitude [°/s²]*
1	0.100	0.0159 Hz	6.000	0.600	0.060
2	0.158	0.0251 Hz	6.000	0.948	0.150
3	0.251	0.0399 Hz	3.984	1.000	0.251
4	0.398	0.0633 Hz	2.513	1.000	0.398
5	0.631	0.1004 Hz	1.585	1.000	0.631
6	1.000	0.1591 Hz	1.000	1.000	1.000
7	1.585	0.251 Hz	0.631	1.000	1.585
8	2.512	0. 399 Hz	0.398	1.000	2.512
9	3.981	0.633 Hz	0.251	1.000	3.981
10	6.310	1.004 Hz	0.158	1.000	6.310
11	10.000	1.591 Hz	0.100	1.000	10.000
12	15.849	2.515 Hz	0.040	0.631	10.000

3.5.6.1.6 Frames of reference. Measurements of the FSTD response should be transformed to estimated measurements at the pilot reference frame. This is defined as being attached to the FSTD in the plane of symmetry of the cab, at a height approximately 35 cm below pilot eye height. The x-axis points forward and the z-axis downward.

3.5.6.1.7 Aircraft characteristics. The tests should be conducted in the FSTD configuration representing the motion drive algorithm during the flight mode. If the motion drive algorithm parameters are different in the ground mode (for example during taxi or take-off roll), then the tests should be repeated for this configuration.

3.5.6.1.8 Presentation of results. The measured modulus and phase should be tabulated for the frequencies given in Table B-2, and for each of the transfer relations given in Table B-1. The results should also be plotted for each component in the test matrix of Table B-1, ranging from 0.0 to 1.0 for the modulus along the horizontal axis, and from 0 to 180 degrees for the absolute value of the phase along the vertical axis.

3.5.6.1.9 Tolerances. Through the ICFQ mechanism (refer to Appendix D to this Part), the tolerances will be implemented into this test.

3.5.6.2 Time-domain criterion.

3.5.6.2.1 Background. *To be defined.*

3.5.6.2.2 List of tests. *To be defined.*

3.5.6.2.3 Priority. *To be defined.*

3.5.6.2.4 Data recording. *To be defined.*

3.5.7 *Vibrations*

3.5.7.1 Presentation of results. The characteristic motion vibrations are a means to verify that the FSTD can reproduce the frequency content of the helicopter when flown in specific conditions. The test results should be presented as a *Power Spectral Density* (PSD) plot with frequencies on the horizontal axis and amplitude on the vertical axis. The helicopter data and FSTD data should be presented in the same format with the same scaling, for a frequency range from 3 Hz to 50 Hz, typically. The algorithms used for generating the FSTD data should be the same as those used for the helicopter data. If they are not the same then the algorithms used for the FSTD data should be proven to be sufficiently comparable. As a minimum, the results along the dominant helicopter axes should be presented and a rationale for not presenting the other axes should be provided.

3.5.7.2 Interpretation of results. The overall trend of the PSD plot should be considered while focusing on the dominant frequencies. Less emphasis should be placed on the differences at the high frequency and low amplitude portions of the PSD plot. During the analysis it should be considered that certain structural components of the FSTD have resonant frequencies that are filtered and thus may not appear in the PSD plot. If such filtering is required, the notch filter bandwidth should be limited to 1 Hz to ensure that the buffet feel is not adversely affected. In addition, a rationale should be provided to explain that the characteristic motion vibration is not being adversely affected by the filtering. The amplitude should match helicopter data as per the following description; however, if for subjective reasons the PSD plot was altered, a rationale should be provided to justify the change. If the plot is on a logarithmic scale, it may be difficult to interpret the amplitude of the buffet in terms of acceleration. A 1×10^{-3} $(g_{rms})^2$/Hz would describe a heavy buffet. On the other hand, a 1×10^{-6} $(g_{rms})^2$/Hz buffet is almost not perceivable but may represent a buffet at low speed. The previous two examples differ in magnitude by 1 000. On a PSD plot this represents three decades (one decade is a change in order of magnitude of 10; two decades is a change in order of magnitude of 100; etc.).

3.6 Visual systems

3.6.1 *General*. Visual systems should be tested in accordance with the table of FSTD validation tests, in paragraph 4. Tests are conducted from eyepoint(s) used by the operating pilot(s).

3.6.2 *Visual ground segment*. See test 4.d.

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

b) The QTG should indicate the source of data, i.e. published decision height, airport and runway used, ILS G/S antenna location (airport and helicopter), pilot eye reference point, cockpit cut-off angle, etc., used to accurately make visual ground segment (VGS) scene content calculations (see Figure B-4).

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

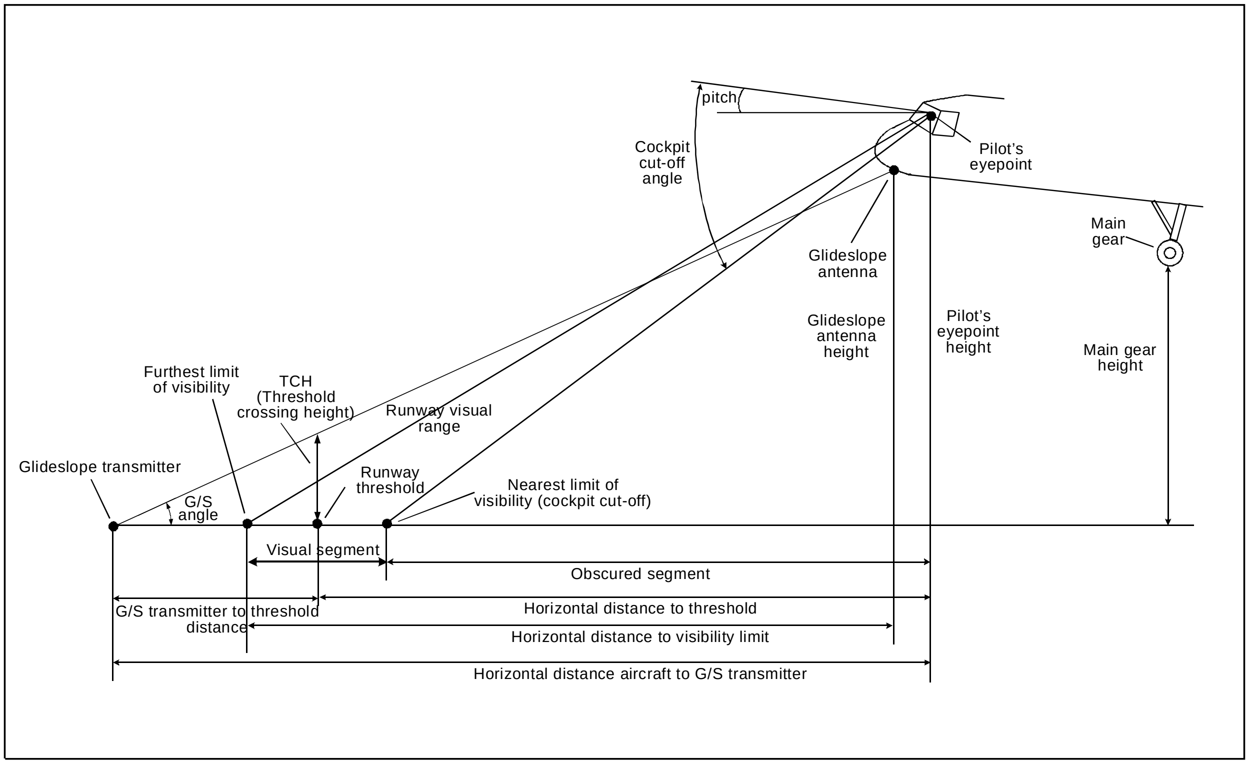


Figure B-4. VGS scene content calculations

3.6.3 *Image geometry*

The geometry of the final image as displayed to each pilot should meet the criteria defined. This assumes that the individual optical components have been tested to demonstrate a performance that is adequate to achieve this end result.

3.6.3.1 Image position. See test 4.a.2.a.1.

When measured from the pilot's and co-pilot's eyepoint the centre of the image should be positioned horizontally between 0 degrees and 2 degrees inboard and within ± 0.25 degree vertically for a collimated display and 0 degrees and 10 degrees inboard and within ± 0.25 degree vertically for a real image display relative to the helicopter centreline taking into account any designed vertical offset.

The differential between the measurements of horizontal position between each eyepoint should not exceed 1 degree.

Note.— The tolerances are based on eye spacings of up to ± 63.5 cm (±25 inches). Greater eye spacings should be accompanied by an explanation of any additional tolerance required. For non-collimated systems the image is positioned at the helicopter centreline for these checks.

3.6.3.2 Image absolute geometry. See test 4.a.2.a.2.

The absolute geometry of any point on the image should not exceed 3 degrees from the theoretical position when aligned to the pilot eyepoint being tested. This tolerance applies to the central 180 degrees by 60 degrees. For larger fields of view there should be no distracting discontinuities outside this area.

3.6.3.3 Image relative geometry. See test 4.a.2.a.3.

The relative geometry check is intended to test the displayed image to demonstrate that there are no significant changes in image size over a small angle of view. With high detail visual systems the eye can be a very powerful comparator to discern changes in geometric size. If there are large changes in image magnification over a small area of the picture the image can appear to "swim" as it moves across the display.

Where a collimated system is used, the typical Mylar-based mirror system will naturally tend to form a "bathtub" shape, and this can cause magnification or "rush" effects at the bottom and top of the image. These effects can be particularly distracting in the lower half of the mirror when in the final approach and hover phase and hence should be minimized. The tolerances are designed to try to keep these effects to an acceptable level while accepting that the technology is limited in its ability to produce a perfect spherical shape.

The field of view is divided up into 3 zones to set tolerances for relative geometry as shown in Figure B-5.

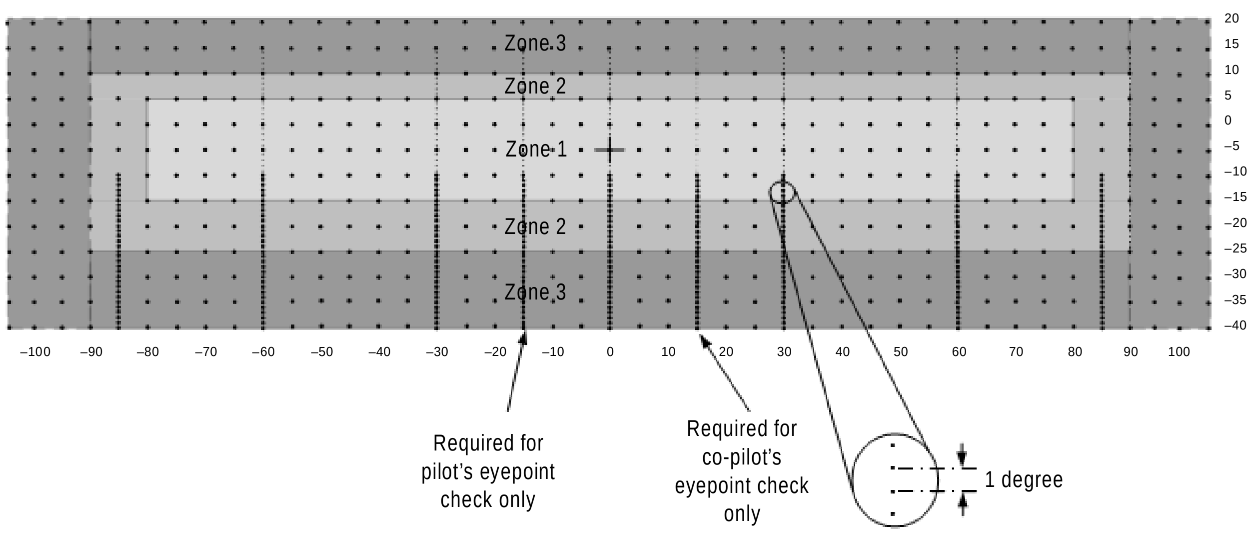


Figure B-5. Relative geometry test pattern showing zones

Three zones are defined in Figure B-5 as follows:

a) Zone 1 covers + 5 degrees to - 15 degrees vertically by ± 80 degrees horizontally;

b) Zone 2 covers + 10 degrees to - 25 degrees vertically by ± 90 degrees horizontally excluding the area covered by Zone 1; and

c) Zone 3 covers + 20 degrees to - 40 degrees vertically by ± 105 degrees horizontally excluding the area covered by Zones 1 and 2.

Testing of the relative geometry should proceed as follows:

a) from the pilot's eye position, measure every visible 5 degree point on the vertical lines and horizontal lines. Also at -15, 0, +30, +60, and +85 degrees in azimuth measure all visible 1 degree points from the -10 degree point to the lowest visible point;

b) from the co-pilot's position, measure every visible 5 degree point on the vertical lines and horizontal lines. Also at the -85, -60, -30, 0 and +15 degrees in azimuth measure all visible 1 degree points from the -10 degree point to the lowest visible point;

c) the relative spacing of points should not exceed the following tolerances when comparing the gap between one pair of dots with the gap between an adjacent pair:

   Zone 1 < 0.075 degree/degree;
   Zone 2 < 0.15 degree/degree; and
   Zone 3 < 0.2 degree/degree;

d) where 5 degree gaps are being measured the tolerances should be multiplied by 5, e.g. one 5 degree gap should not be more than (5*0.075) = 0.375 degree more or less than the adjacent gap when in Zone 1; and

e) for larger fields of view there should be no distracting discontinuities outside the area represented in Figure B-5.

For recurrent testing, the use of an optical checking device is encouraged. This device should typically consist of a hand-held go/no go gauge to check that the relative positioning is maintained.

3.6.4 *Speckle contrast ratio*

Speckle is normally associated with projectors using light sources with some amount of coherence, such as lasers, and is measured where the effects can be distracting in the final image. The objective measure of speckle contrast that is described in the following paragraphs considers the grainy structure of speckle and concentrates on the variations of brightness inherently introduced by speckle. Speckle contrast is quite commonly measured in many applications. However, speckle contrast does not take into account the size of the grains, i.e. the spatial wavelength of the speckle pattern.

3.6.4.1 Definition of speckle contrast ratio

Due to its noisy character, one adequate measure to quantify speckle is the root mean square (RMS) deviation derived from statistical theory: in a random distribution, the RMS deviation quantifies the amount of variation from the mean value.

When applied to the intensity profile of an illuminated surface, the speckle contrast C is the RMS deviation normalized to the mean value.

Given the intensity profile I(x, y) in the considered field of view, the speckle contrast C can be defined as:

$$C = \frac{\sqrt{\langle I^2 \rangle - \langle I \rangle^2}}{\langle I \rangle},$$

where the average operator < > operating on a profile I(x, y) is defined as:

$$\langle I \rangle = \frac{1}{A} \cdot \int_{FOV} I(x,y) dA$$

Hence:

$$C = \frac{\sqrt{A \cdot \int_{FOV} \left(I(x,y)\right)^2 dA - \left(\int_{FOV} I(x,y) dA\right)^2}}{\int_{FOV} I(x,y) dA}$$

3.6.4.2 Speckle measurement

The intensity profile I(x, y) can be measured with a CCD camera. The setup of the measurement (selection of lenses and CCD array) ensures that the granularity of the speckle can easily be resolved; hence, the granularity on the CCD-chip should therefore be larger than the pixel size.

With the discrete nature of the CCD chip, I(x, y) translates into an array $I_{m,n}$, while $\frac{1}{A} \cdot \int_{FOV} I(x,y) dA$

translates into $\frac{1}{m \cdot n} \cdot \sum_{FOV} I_{m,n}$

Therefore,

$$C = \frac{\sqrt{m \cdot n \cdot \sum_{FOV} I_{m,n}^2 - \left(\sum_{FOV} I_{m,n}\right)^2}}{\sum_{FOV} I_{m,n}}$$

Where:

Symbol or Notation	*Description*	*Units*
Σ	Summation operator	N/A
A	Area	Arbitrary units
C	Speckle contrast	Per cent
FOV	Field of view	Degrees
I	Intensity	Arbitrary units
m	Number of pixel rows within FOV.	N/A
n	Number of pixel columns within FOV.	N/A

Since the definition of *C* is also sensitive to the profile's low-frequency variations across the FOV, either the illumination together with the reflectivity of the screen should be homogeneous, or the measured intensity profile should be corrected for these variations. This can be accomplished by applying a suitable high-pass filter, for example, by evaluating on sufficiently small FOVs in which low-frequency variations are negligible.

To take into account the subjective nature of speckle, the f-number (or f# which is sometimes called the focal ratio expressing the diameter of the entrance pupil D divided by the focal length f, i.e. D/f) of the lens should be used as close as possible to that of the human eye. The recommended f# is 1/16.

3.6.4.3 Speckle tolerance*.* See test 4.a.11.

If the speckle contrast is more than 10 per cent the image begins to appear disturbed. The distractive modulation as an overlay of the image reduces the perceptibility of the projected image and then degrades the perceived resolution. With a speckle contrast below 10 per cent, the resolution and focus are not affected.

3.7 Sound system

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

3.7.2 *Alternate engine fits.* For FSTDs with multiple engine configurations, any condition listed in Appendix B, tests 5 (Sound system) of the table of FSTD validation tests and that is identified by the helicopter manufacturer as significantly different, due to a change in engine model, should be presented for evaluation as part of the QTG.

3.7.3 *Data and data collection system.*

3.7.3.1 Information provided to the FSTD manufacturer should comply with the RAeS *Data Package Requirements for Design and Performance Evaluation of Rotary Wing Synthetic Training Devices,* first release, April 2004, as amended. This information should contain calibration and frequency response data.

3.7.3.2 The system used to perform the tests listed in Appendix B, tests 5 (Sound system) of the table of FSTD validation tests, should meet or exceed the following standards:

a) ANSI S1.11-2004, as amended — Specification for octave, half octave and third octave band filter sets; and

b) IEC 1094-4-1995, as amended — Measurement microphones — Frequency response of the microphone used to record the FSTD sounds should be at least as good as the one used to record the approved data set sounds.

3.7.4 *Headsets.* If headsets are used during normal operation of the helicopter they should also be used during the FSTD evaluation.

3.7.5 *Playback equipment.* It is recommended that playback equipment such as a laptop and headphones and recordings from the approved data set be available during initial evaluations in order to enable subjective comparison between FSTD results and the approved data.

3.7.6 *Volume level.* The FSTD is qualified at the full volume level, which corresponds to the actual volume level in the approved data set. When full volume is not selected, an indication of abnormal setting should be provided to the instructor to prevent inadvertent operation at this setting.

3.7.7 *Background noise.*

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

3.7.7.2 The acceptability of the background noise levels is dependent upon the normal sound levels in the helicopter being represented. Background noise levels that fall below the lines defined by the following points may be acceptable (refer to Figure B-6):

a) 70 dB @ 50 Hz;
b) 55 dB @ 1 000 Hz; and
c) 30 dB @ 16 kHz.

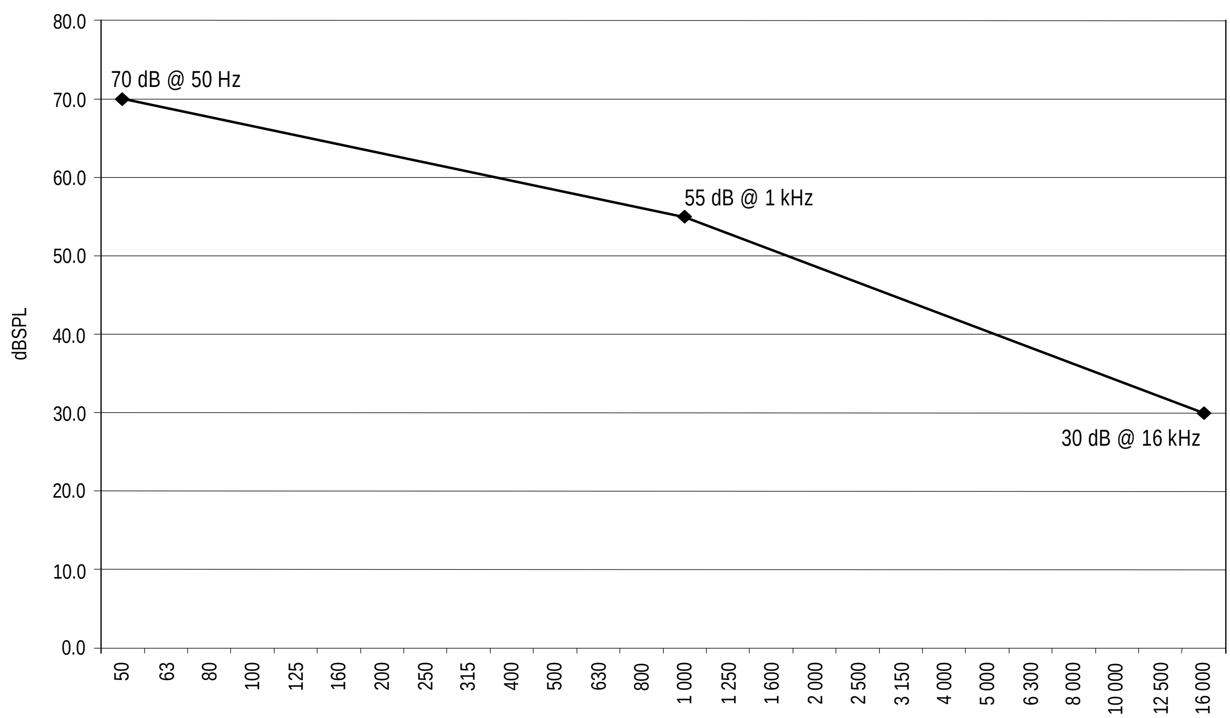


Figure B-6. 1/3 octave band frequency (Hz)

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

3.7.7.3 The background noise measurement may be rerun at the recurrent evaluation as per paragraph 3.7.9. The tolerances to be applied are: recurrent 1/3 octave band amplitudes cannot differ by more than ± 3 dB when compared to the initial results.

3.7.8 *Frequency response.* Frequency response plots for each channel should be provided at initial evaluation. These plots may be rerun at the recurrent evaluation as per paragraph 3.7.9. The tolerances to be applied are:

a) recurrent 1/3 octave band amplitudes cannot differ by more than ± 5 dB for three consecutive bands when compared to the initial results; and

b) the average of the sum of the absolute differences between initial and recurrent results over all bands cannot exceed 2 dB (see Table B-5).

Table B-5. Example of recurrent frequency response test tolerance

Band centre frequency	*Initial results (dBSPL)*	*Recurrent results (dBSPL)*	*Absolute difference*
50	75.0	73.8	1.2
63	75.9	75.6	0.3
80	77.1	76.5	0.6
100	78.0	78.3	0.3
125	81.9	81.3	0.6
160	79.8	80.1	0.3
200	83.1	84.9	1.8
250	78.6	78.9	0.3
315	79.5	78.3	1.2
400	80.1	79.5	0.6
500	80.7	79.8	0.9
630	81.9	80.4	1.5
800	73.2	74.1	0.9
1 000	79.2	80.1	0.9
1 250	80.7	82.8	2.1
1 600	81.6	78.6	3.0
2 000	76.2	74.4	1.8

Band centre frequency	*Initial results (dBSPL)*	*Recurrent results (dBSPL)*	*Absolute difference*
2 500	79.5	80.7	1.2
3 150	80.1	77.1	3.0
4 000	78.9	78.6	0.3
5 000	80.1	77.1	3.0
6 300	80.7	80.4	0.3
8 000	84.3	85.5	1.2
10 000	81.3	79.8	1.5
12 500	80.7	80.1	0.6
16 000	71.1	71.1	0.0
		Average	1.1

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

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

a) variation of data between tail numbers;

b) frequency response of microphones;

c) repeatability of the measurements; and

d) extraneous sounds during recordings.

Note.— Atmospheric pressure differences between data collection and reproduction may play a role in subjective perceptions.

4. TABLE OF FSTD VALIDATION TESTS

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.	**PERFORMANCE**								All the one engine inoperative tests in this section are only applicable to multi-engine helicopters.
1.a	**Engine assessment**								
1.a	1) Start operation. i) Engine start and acceleration (transient).	Light off time ± 10% or ± 1 s. Torque ± 5%. Rotor speed ± 3%. Gas generator speed ± 5%. Power turbine speed ± 5%. Turbine gas temperature ± 30°C.	Ground, rotor brake not used and rotor brake used (if applicable).			✓	✓	✓	Time histories of each engine from initiation of start sequence to steady state idle and from steady state idle to operating RPM. For a multi-engine helicopter, the test should be presented as a start of two engines in sequence. Tolerance to be applied only in the validity domain of the engine parameter sensors.
	ii) Steady state idle and operating RPM conditions.	<u>For S fidelity level</u>: Torque ± 3%. Rotor speed ± 1.5%. Gas generator speed ± 2%. Power turbine speed ± 2% Turbine gas temperature ± 20°C.	Ground.			✓	✓	✓	Data should be presented for both steady state idle and operating RPM conditions. It may be a snapshot test.
		<u>For G and R fidelity levels</u>: Torque ± 3%. Rotor speed ± 1.5%.		✓	✓				

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.a	2) Power turbine speed trim.	± 10% of total change of power turbine speed or ± 1.5% rotor speed.	Ground.			✓	✓	✓	Time history of engine response to trim system actuation (both directions).
1.a	3) Engine and rotor speed governing.	Torque ± 5%. Rotor speed ± 1.5%.	Climb and descent.			✓	✓	✓	Collective step inputs. Can be conducted with climb and descent performance tests. Two tests are required: – one test demonstrating collective up input; and – one test demonstrating a collective down input.
1.b	**Ground operations**								
1.b	1) Reserved.								
1.b	2) Rate of turn vs pedal deflection or steering wheel angle.	Turn rate ± 10% or ± 2°/s.	Ground.			✓	✓	✓	Without use of wheel brake. Test to demonstrate the helicopter response to both direction inputs.
1.b	3) Taxi.	Torque ± 3%. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%.	Ground.			✓	✓	✓	Control position during ground taxi for a specific ground speed and direction, and density altitude.
1.b	4) Reserved.								

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.c	**Take-off**								When the speed range for the following tests is less than 40 knots, the applicable airspeed tolerance may be applied to either airspeed or ground speed, as appropriate. If height is not available altitude may be used.
1.c	1) All engines.	<u>For S fidelity level</u>: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 2°. Heading ± 2°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Hover.			✓	✓	✓	Time history of take-off flight path as appropriate to helicopter model simulated and FSTD type. Take-off from hover IGE. Record data to at least 61 m (200 ft) AGL/V_y whichever comes later.
		<u>For R fidelity level</u>: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 2.5°. Roll angle ± 2°. Heading ± 2°.		✓	✓				

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.c	2) One engine inoperative continued take-off.	<u>For S fidelity level</u>: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 2°. Heading ± 2°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Hover.			✓	✓	✓	Time history of take-off flight path as appropriate to helicopter model simulated. Record data to at least 61 m (200 ft) AGL/V_y whichever comes later. This test corresponds to an open field CAT A take-off with an engine failure after TDP. *Note.— See paragraph 1.7 in Attachment J to this Part about the possibility of deriving reference data in OEI condition for a helicopter equipped with an OEI training mode.*
		<u>For R fidelity level</u>: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor Speed ± 1.5%. Pitch angle ± 2.5°. Roll angle ± 2°. Heading ± 2°.		✓	✓				

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.c	3) One engine inoperative rejected take-off.	For S fidelity level: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 1.5°. Heading ± 2°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%. Distance: ± 7.5% or ± 30 m (100 ft).	Hover.			✓	✓	✓	Time history from the take-off point until touchdown. Test conditions near limiting performance. This test corresponds to an open field CAT A take-off with an engine failure before TDP. *Note.— See paragraph 1.7 in Attachment J to this Part about the possibility of deriving reference data in OEI condition for a helicopter equipped with an OEI training mode.*
		For R fidelity level: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 2.5°. Roll angle ± 1.5°. Heading ± 2°. Distance: ± 7.5% or ± 30 m (100 ft).		✓	✓				

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.c	4) Lift-off to hover.	Torque ± 5%. Pitch angle ± 2°. Roll angle ± 2°. Heading ± 3°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Ground. Stability augmentation ON or OFF.			✓	✓	✓	Record a manoeuvre starting on ground with collective full down till stabilized in hover IGE.
1.d	**Hover performance**	For S and R fidelity levels: Torque ± 3%. Pitch angle ± 1.5°. Roll angle ± 1.5°. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%.	In ground effect (IGE). Out of ground effect (OGE). Stability augmentation ON and OFF.	✓	✓	✓	✓	✓	Light and heavy gross masses. Four test conditions are required: • 10%, 30% and 70% of rotor diameter height for IGE; and • more than 150% of rotor diameter height for OGE. These may be snapshot tests.
		For G fidelity level: Torque ± 3%. Collective control position ± 5%.							Two test conditions are required: • IGE; and • OGE. These may be snapshot tests.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.e	**Vertical climb performance**	Vertical velocity ± 0.50 m/s (100 ft/min) or ± 10%. Directional control position ± 5%. Collective control position ± 5%.	OGE. Stability augmentation ON and OFF.	✓	✓	✓	✓	✓	Light and heavy gross masses. These may be snapshot tests.
1.f	**Level flight performance and trimmed flight control position**	Torque ± 3%. Pitch angle ± 1.5°. Sideslip angle ± 2°. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%.	Cruise. Stability augmentation ON or OFF.						These may be snapshot tests. Test results presented as a cross-plot against speed are encouraged.
		For S fidelity level: Tolerances as above.				✓	✓	✓	Two combinations of gross mass/CG and for each combination several speeds from V_y up to V_H within the flight envelope.
		For R fidelity level: Tolerances as above.		✓	✓				Two combinations of gross mass/CG and for each combination several speeds from V_y up to V_H within the flight envelope. (ctd on next page)

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
									Sideslip angle is matched only for repeatability and only on continuing recurrent evaluations.
		For G fidelity level: Tolerances as above.							Not applicable to Types I to V. (for information only) Two combinations of gross mass/CG and for each combination two speed values. Sideslip angle is matched only for repeatability and only on continuing recurrent evaluations.
1.g	**Climb performance and trimmed flight control position**	Vertical velocity ± 0.50 m/s (100 ft/min) or ± 10%. Pitch angle ± 1.5°. Sideslip angle ± 2°. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%. Airspeed ± 3 kts.	All engines operating. One engine inoperative. Stability augmentation ON or OFF.	✓	✓	✓	✓	✓	Two gross mass/CG combinations. Data presented at relevant climb power conditions. These may be snapshot tests. Tolerance on speed is only applicable to time history tests. For R and S fidelity levels (Types I through V): The achieved measured vertical velocity of the FSTD cannot be less than the appropriate approved RFM values. For R fidelity level (Types I and II): Sideslip angle is matched for repeatability only and on continuing recurrent evaluations only.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.h	**Descent**								
1.h	1) Descent performance and trimmed flight control position.	Torque ± 3%. Pitch angle ± 1.5°. Sideslip angle ± 2°. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%. Airspeed ± 3 kts.	Powered descent. Stability augmentation ON or OFF.	✓	✓	✓	✓	✓	Two gross mass/CG combinations. These may be snapshot tests. Test to demonstrate a significant rate of descent using a normal approach speed. Tolerance on speed is only applicable to time history tests. <u>For R fidelity level (Types I and II)</u>: Sideslip angle is matched for repeatability only and on continuing recurrent evaluations only.
1.h	2) Autorotation performance and trimmed flight control position.	Vertical velocity ± 0.50 m/s (100 ft/min) or ± 10%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Sideslip angle ± 2°. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%.	Steady descents. Stability augmentation ON or OFF.	✓	✓	✓	✓	✓	Two gross mass/CG combinations. Rotor speed tolerance applies only if collective control position is fully down. Speed sweep from approximately the minimum rate of descent airspeed to at least either maximum glide distance airspeed or maximum allowable power-off airspeed, whichever is slower. These may be a series of snapshot tests. <u>For R fidelity level (Types I and II)</u>: Sideslip angle is matched for repeatability only and on continuing recurrent evaluations only.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.i	**Autorotational entry**	For S fidelity level: Torque ± 3%. Rotor speed ± 3%. Pitch angle ± 2°. Roll attitude ± 3°. Heading ± 5°. Airspeed ± 5 kts. Altitude ± 6.1 m (20 ft). Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Cruise and climb.			✓	✓	✓	Time history of helicopter response following a rapid power reduction to idle up to a stabilized autorotation rate of descent and N_R. For cruise, data should be presented for a high speed condition. For climb, data should be presented for the maximum rate of climb airspeed at or near maximum continuous power.
		For R fidelity level: Torque ± 3%. Rotor speed ± 3%. Pitch angle ± 2°. Roll attitude ± 3°. Heading ± 5°. Airspeed ± 5 kts. Altitude ± 6.1 m (20 ft).	Cruise and climb.	✓	✓				

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.j	**Landing**								When the speed range for the following tests is less than 40 knots, the applicable airspeed tolerance may be applied to either airspeed or ground speed, as appropriate. If height is not available altitude may be used.
1.j	1) All engines.	For S fidelity level: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 2°. Heading ± 2°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Approach to hover.			✓	✓	✓	Time history of approach and landing profile down to IGE hover as appropriate to the helicopter model being simulated.
		For R fidelity level: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 2.5°. Roll angle ± 2°. Heading ± 2°.		✓	✓				Time history of approach and landing profile down to IGE hover as appropriate to the group of helicopters being simulated.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.j	2) One engine inoperative.	<u>For S fidelity level</u>: Airspeed ± 3 kts Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 2°. Heading ± 2°. Longitudinal Control Position ± 10%. Lateral Control Position ± 10%. Directional Control Position ± 10%. Collective Control Position ± 10%.	Approach and landing.			✓	✓	✓	Include data for both CAT A and CAT B approaches and landings as appropriate to the helicopter model being simulated. Test ends when all the elements of the undercarriage are on the ground. *Note.— See paragraph 1.7 in Attachment J to this Part about the possibility of deriving reference data in OEI condition for a helicopter equipped with an OEI training mode.*
		<u>For R fidelity level</u>: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 2.5°. Roll angle ± 2°. Heading ± 2°.		✓	✓				Include data for both CAT A and CAT B approaches and landings as appropriate to the group of helicopters being simulated. Test ends when the first element of the undercarriage touches the ground.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.j	3) Balked landing/missed approach.	<u>For S fidelity level</u>: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 2°. Heading ± 2°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Approach, one engine inoperative.			✓	✓	✓	Test to demonstrate a missed approach manoeuvre that is performed from an OEI stabilized approach or includes a dynamic engine failure during the approach. *Note.— See paragraph 1.7 in Attachment J to this Part about the possibility of deriving reference data in OEI condition for a helicopter equipped with an OEI training mode.*
		<u>For R fidelity level</u>: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 2.5°. Roll angle ± 2°. Heading ± 2°.		✓	✓				

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.j	4) Autorotational landing.	Airspeed ± 3 kts. Torque ± 3%. Rotor speed ± 3%. Height ± 6.1 m (20 ft). Pitch angle ± 2°. Roll angle ± 2°. Heading ± 5°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Approach and touchdown.			✓	✓	✓	Time history of autorotational deceleration and touchdown from a stabilized autorotational descent. If flight test data containing all required parameters for a complete power-off landing are not available from the aircraft manufacturer for this test and other qualified flight test personnel are not available to acquire these data, the operator may coordinate with the NAA to determine if it is appropriate to accept alternative testing means. Alternative approaches for acquiring these data may be acceptable, depending on the aircraft as well as the personnel and the data recording, reduction and interpretation facilities to be used. These alternative approaches are: 1) a simulated autorotational flare and reduction of rate of descent (R/D) at altitude; or 2) a power-on termination following an autorotational approach and flare.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
1.j	5) Hover to touchdown.	Torque ± 5%. Pitch angle ± 2°. Roll angle ± 2°. Heading ± 3°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	IGE hover. Stability augmentation ON or OFF.			✓	✓	✓	Record a manoeuvre starting from IGE hover till touchdown ending with collective control full down.
1.k	**Level flight acceleration**	<u>For S fidelity level</u>: Airspeed ± 3 kts. Longitudinal, lateral, directional and collective control positions ± 10%. Torque ± 3%. Pitch angle ± 2°. Roll angle ± 2°. Heading ± 2°.	Cruise. Stability augmentation ON or OFF.			✓	✓	✓	Record a coordinated level flight acceleration with a minimum approximate speed range increase from V_y to maximum range airspeed, initiated with a single power increase at the beginning of the manoeuvre (not a continuous increase).
		<u>For R fidelity level</u>: Airspeed ± 3 kts. Torque ± 3%. Pitch angle ± 2°. Roll angle ± 2°. Heading ± 2°.		✓	✓				

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.	**HANDLING QUALITIES**								
2.a.	**Control system mechanical characteristics**								
	Note 1.— Pitch, roll, yaw and collective controller position versus force or time should be measured at the control. An alternative method in lieu of external test fixtures at the flight controls would be to have recording and measuring instrumentation built into the FSTD. The force and position data from this instrumentation could be directly recorded and matched to the helicopter data. Provided the instrumentation was verified by using external measuring equipment while conducting the static control checks, or equivalent means, and that evidence of the satisfactory comparison is included in the MQTG, the instrumentation could be used for both initial and recurrent evaluations for the measurement of all required control checks. Such a permanent installation could be used without any time being lost for the installation of external devices. *Verification of the instrumentation by using external measuring equipment should be repeated if major modifications and/or repairs are made to the control loading system.* *Note 2.— FSTD static control testing (tests 2.a.1 and 2.a.2) from the second set of pilot controls is required only if both sets of controls are not mechanically interconnected on the FSTD. A rationale is required from the data provider if a single set of data is applicable to both sides. If controls are mechanically interconnected in the FSTD, a single set of tests is sufficient. Dynamics testing is not required at both pilot positions.* *Note 3.— For the control sweep tests (tests 2.a.1, 2.a.2 and 2.a.3), in order to enable validation of steep force gradients near control stops, an additional tolerance of ± 1.5% of total travel on the position axis should be applied.* Contact your NAA for clarification of any issue regarding helicopters with reversible controls or where the required validation data are not attainable.								

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.a.	1) Cyclic.	Breakout ± 0.111 daN (0.25 lbf) or ± 25%. Force ± 0.222 daN (0.5 lbf) or ± 10%.	Ground. Static conditions with the hydraulic system (if applicable) pressurized. Supplemental hydraulic pressurization system may be used. Trim ON and OFF. Friction OFF. Stability augmentation (if applicable) ON and OFF.	✓	✓	✓	✓	✓	Record results for an uninterrupted control sweep to the stops (this test does not apply if aircraft hardware modular controllers are used). Flight test data for this test do not require the rotor to be engaged/turning. The words “if applicable” regarding stability augmentation systems mean: if an augmentation system is available and if this system may be operational on the ground under static conditions as described here.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.a.	2) Collective/ Pedals.	Breakout ± 0.222 daN (0.5 lbf) or ± 25%. Force ± 0.445 daN (1.0 lbf) or ± 10%.	Ground. Static conditions with the hydraulic system (if applicable) pressurized. Supplemental hydraulic pressurization system may be used. Trim ON and OFF. Friction OFF. Stability augmentation (if applicable) ON and OFF.	✓	✓	✓	✓	✓	Record results for an uninterrupted control sweep to the stops. Flight test data for this test do not require the rotor to be engaged/turning. The words “if applicable” regarding stability augmentation systems mean: if an augmentation system is available and if this system may be operational on the ground under static conditions as described here.
2.a.	3) Brake pedal force vs position.	Force ± 2.224 daN (5 lbf) or ± 10%.	Ground. Static conditions.	✓	✓	✓	✓	✓	FSTD computer output results may be used to show compliance. When the aircraft braking system is an independent system, the tolerances should be applied only on the breakout and maximum deflection.
2.a.	4) Trim system rate (all applicable systems).	Rate ± 10%.	Ground. Static conditions. Trim ON. Friction OFF.	✓	✓	✓	✓	✓	The tolerance applies to the recorded value of the trim rate.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.a.	5) Control dynamics (all axes). (2.a (5) ctd on next page)	**For underdamped systems** (as per Figure B-1 of this Appendix): $T(P_0)$ ± 10% of P_0 or ± 0.05 s. $T(P_1)$ ± 20% of P_1 or ± 0.05 s. $T(P_2)$ ± 30% of P_2 or ± 0.05 s. $T(P_n)$ ± 10*(n+1)% of P_n or ± 0.05 s. $T(A_n)$ ± 10% of A_{max}, where A_{max} is the largest amplitude of the first overshoot or ± 0.5% of the total control travel (stop to stop). $T(A_d)$ ± 5% of A_d = residual band or ± 0.5% of the total control travel = residual band. Oscillations within the residual band are not considered significant and are not subject to tolerances.	Ground. Static conditions for irreversible flight control systems. Trim ON. Friction OFF.			✓	✓	✓	Results must be recorded for a normal control displacement in both directions in each axis. Typically, control displacement of 10% to 20% of total control travel is necessary for proper excitation. Control dynamics for reversible control systems should be evaluated in flight considering safety issues or using an alternate method to be proposed to and agreed with the NAA on a case-by-case basis. Additional information on control dynamics is found in paragraphs 3.2.2 to 3.2.5 of this Appendix. "n" is the sequential period of a full cycle of oscillation. For any control (typically pedals and collective) that does not exhibit any spring characteristics an alternate method to demonstrate compliance should be run such as running control sweep at high speed. Refer to paragraph 3.2.3 of this Appendix.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		± 1 significant overshoots (minimum of 1 significant overshoot). Steady state position should be within residual band. **For overdamped and critically damped systems only**, the following tolerance applies: $T(P_0)$ ± 10% of P_0 or ± 0.05 s.							
2.b.	**Low airspeed handling qualities**								
2.b.	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, and forward flight. Stability augmentation ON or OFF.	✓	✓	✓	✓	✓	Record results for several speed increments to the translational airspeed limits and up to 45 kts forward airspeed (at least four values for the forward flight). This may be a series of snapshot tests. Presenting test results as a cross-plot against speed is encouraged.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.b.	2) Critical azimuth (or azimuth of minimum control margin)	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 or OFF.	✓	✓	✓	✓	✓	Record results for three relative wind directions (including the most critical case) in the critical quadrant. An SOC is required to define from the helicopter design and RFM or flight test data how to present the results showing the area where the minimum control margin applies. This may be a series of snapshot tests. Precise wind measurement is very difficult and simulated wind obtained by translational flight in calm weather condition (no wind) is preferred in order to control precisely flight conditions by using groundspeed measurement (usually GPS). In this condition, it would be more practical to collect validation data for this test with tests 2.b (1) in order to ensure consistency between critical azimuth and other directions (forward, sideward and rearward).

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.b.	3) Control response.								Record results for a step control input on the test axis. The off-axes response must show correct trend. This is a short time test that may be conducted in ground effect to provide better visual reference. The control response tests consist of the four tests (3a) to (3d) below.
2.b.	3a) Longitudinal.	Pitch rate ± 10% or ± 2°/s. Pitch attitude change ± 10% or ± 1.5°.	Hover. Stability augmentation ON and OFF.			✓	✓	✓	Attitude change is defined as the attitude change from the value just before the step input. The tolerance is applied continuously from the step input time.
2.b.	3b) Lateral.	Roll rate ± 10% or ± 3°/s. Roll attitude change ± 10% or ± 3°.	Hover. Stability augmentation ON and OFF.			✓	✓	✓	Attitude change is defined as the attitude change from the value just before the step input. The tolerance is applied continuously from the step input time.
2.b.	3c) Directional.	Yaw rate ± 10% or ± 2°/s. Heading change ± 10% or ± 2°.	Hover. Stability augmentation ON and OFF. Both directions.			✓	✓	✓	Attitude change is defined as the attitude change from the value just before the step input. The tolerance is applied continuously from the step input time.
2.b.	3d) Vertical.	Normal Acceleration ± 0.1 g. Vertical velocity ± 10% or ± 0.50 m/s (100 ft/min).	Hover. Stability augmentation ON and OFF.			✓	✓	✓	

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.c.	**Longitudinal handling qualities**								
2.c.	1) Control response.	Pitch rate ± 10% or ± 2°/s. Pitch attitude change ± 10% or ± 1.5°.	Cruise. Stability augmentation ON and OFF.	✓	✓	✓	✓	✓	Results should be recorded for two cruise airspeeds to include minimum power required speed. Record results for a step control input on the test axis. The off-axes response must show correct trend. Attitude change is defined as the attitude change from the value just before the step input. The tolerance is applied continuously from the step input time.
2.c.	2) Static stability.	Longitudinal control position change from trim: ± 10% or ± 6.3 mm (0.25 in.); or longitudinal control force change from trim: ± 0.222 daN (0.5 lbf) or ± 10%.	Cruise or climb. Autorotation. Stability augmentation ON or OFF. Stability augmentation ON **and** OFF conditions are required if the augmentation system includes airspeed regulation.	✓	✓	✓	✓	✓	Record results for a minimum of two speeds on each side of the trim speed taken as reference. This may be a series of snapshot tests.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.c.	3) Dynamic stability.								The dynamic stability tests consist of the two tests (3a) and (3b) below.
2.c.	3a) Long-term response.	± 10% of calculated period. ± 10% of time to 1/2 or double amplitude, or ± 0.02 of damping ratio. For non-periodic responses, the time history must be matched over a 20 s period following release of the controls within ± 20% or ± 3° of pitch attitude change; and ± 5 kts of airspeed.	Cruise. Stability augmentation OFF.	✓	✓	✓	✓	✓	For periodic responses, record results for three full cycles (six overshoots after input is completed) or that sufficient to determine time to one-half or double amplitude, whichever is less. The test may be terminated prior to 20 s if the test pilot determines that the results are becoming uncontrollably divergent. The response may be unrepeatable throughout the stated time for certain helicopters. In these cases, the test should show at least that a divergence is identifiable. For example: displacing the cyclic for a given time or until a given pitch attitude is achieved normally excites this test and then returning the cyclic to the original position. For non-periodic responses, results should show the same convergent or divergent character as the flight test data.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.c.	3b) Short-term response.	± 1.5° pitch angle or ± 2°/s pitch rate. ± 0.1 g normal acceleration.	Cruise or climb. Stability augmentation ON and OFF.	✓	✓	✓	✓	✓	Record results for at least two airspeeds. A control doublet inserted at the natural frequency of the aircraft normally excites this test. However, while input doublets are preferred over pulse inputs for augmentation-OFF tests, for augmentation-ON tests, when the short-term response exhibits first-order or deadbeat characteristics, longitudinal pulse inputs may produce a more coherent response. *Note 1.— A Doublet (Longitudinal) input may be generated by pulling back the pitch control sharply and holding input for 5 seconds, pushing forward the pitch control sharply and holding input for 5 seconds, and then releasing the pitch control to neutral position. Inputs should be large enough to produce ± 0.2g load factor and/or ± 5 to 15 degree pitch attitude excursions.* *Note 2.— Deadbeat response to step commands is demonstrated by a system that rapidly reaches a stable state and holds that state with minimal overshoot.*
2.c.	4) Manoeuvring stability.	Longitudinal control position change from trim: ± 10% or ± 6.3 mm (0.25 in.); or longitudinal control force change from trim: ± 0.222 daN (0.5 lbf) or ± 10%.	Cruise or climb. Stability augmentation ON or OFF. Left and right turns.	✓	✓	✓	✓	✓	Results should be recorded for two airspeeds to include minimum power required speed. For each airspeed condition the results should include roll angles at approximately 30° and 45°. The force may be shown as a cross plot for irreversible systems. This may be a series of snapshot tests.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.d.	**Lateral and directional handling qualities**								
2.d.	1) Control response.								The control response tests consist of the two tests (1a) and (1b) below.
2.d.	1a) Lateral.	Roll rate ± 10% or ± 3°/s. Roll attitude change ± 10% or ± 3°.	Cruise. Stability augmentation ON and OFF.	✓	✓	✓	✓	✓	Record results for at least two airspeeds, including the speed at or near the minimum power required airspeed. Record results for a step control input on the test axis. The off-axes response must show correct trend. Attitude change is defined as the attitude change from the value just before the step input. The tolerance is applied continuously from the step input time.
2.d.	1b) Directional.	Yaw rate ± 10% or ± 2°/s. Heading change ± 10% or ± 2°.	Cruise. Stability augmentation ON and OFF.	✓	✓	✓	✓	✓	Record results for at least two airspeeds, including the speed at or near the minimum power required airspeed. Record results for a step control input on the test axis. The off-axes response must show correct trend. Heading change is defined as the heading change from the value just before the step input. The tolerance is applied continuously from the step input time.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.d.	2) Directional static stability.	Roll attitude ± 1.5°. Vertical velocity ± 10% or ± 0.50 m/s (100 ft/min). Lateral control position change from trim: ± 10% or ± 6.3 mm (0.25 in.); or lateral control force change from trim: ± 10% or ± 0.222 daN (0.5 lbf). Directional control position change from trim: ± 10% or ± 6.3 mm (0.25 in.); or directional control force change from trim: ± 10% or ± 0.444 daN (1 lbf). Longitudinal control position change from trim: ± 10% or ± 6.3 mm (0.25 in.); or longitudinal control force change from trim: ± 10% or ± 0.222 daN (0.5 lbf).	Climb or descent. Stability augmentation ON or OFF.	✓	✓	✓	✓	✓	Record results for at least two sideslip angles on either side of the trim point. The force may be shown as a cross plot for irreversible systems. This may be a series of snapshot tests. This is a steady heading sideslip test at a fixed collective position.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.d.	3) Dynamic lateral and directional stability.								The dynamic lateral and directional stability tests consist of the three tests (3a) to (3c) below.
2.d.	3a) Lateral-directional oscillations.	± 0.5 s or ± 10% of period. ± 10% of time to 1⁄2 or double amplitude or ± 0.02 of damping ratio. ± 20% or ± 1 s of time difference between peaks of bank and sideslip. For non-periodic responses, the time history must be matched over a 20 s period following release of the controls within: ± 5°/s of roll rate or ± 5° of roll attitude change; and ± 4°/s of yaw rate or ± 4° of heading.	Cruise or climb. Stability augmentation ON and OFF.	✓	✓	✓	✓	✓	Record results for at least two airspeeds. The test must be initiated with a cyclic or a pedal doublet input. Record results for six full cycles (12 overshoots after input is completed) or a number of cycles sufficient to determine time to one-half or double amplitude, whichever is less. The test may be terminated prior to 20 s if the test pilot determines that the results are becoming uncontrollably divergent.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
2.d.	3b) Spiral stability.	Correct trend and ± 2° or ± 10% of roll angle in 20 s. If alternate test is used: Lateral control position change from trim: ± 20% or ± 12.7 mm (0.5 in.).	Cruise or climb. Stability augmentation ON and OFF.	✓	✓	✓	✓	✓	Record the results of turns for 20 s following a release from pedal-only or cyclic-only inputs. Results must be recorded from turns in both directions. Terminate the test at zero roll angle or when the test pilot determines that the attitude is becoming uncontrollably divergent. Aircraft data averaged from multiple tests may be used. Test for both directions. As an alternative test: record the results of the lateral cyclic input only (no pedal input) required to maintain a bank angle position of approximately 30 degrees from a steady flight trim. This may be a series of snapshot tests.
2.d.	3c) Adverse/ proverse yaw.	Correct trend. ± 2° transient sideslip angle.	Cruise or climb. Stability augmentation ON and OFF. Stability augmentation ON case to include turn coordination system, if available.	✓	✓	✓	✓	✓	Record the time history of initial entry into cyclic-only turns, using only a moderate rate for cyclic input. Results must be recorded for turns in both directions.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
3.	**MOTION SYSTEM**								
3.a.	**Frequency response**	As specified by the applicant for FSTD qualification.	Not applicable.				✓	✓	An appropriate test to demonstrate the frequency response is required. See also paragraphs 3.5.2 and 3.5.3 of this Appendix.
3.b.	**Turnaround check**	As specified by the applicant for FSTD qualification.	Not applicable.				✓	✓	An appropriate test to demonstrate a smooth turnaround is required. See also paragraphs 3.5.2 and 3.5.4 of this Appendix.
3.c.	**Motion effects**								Refer to Appendix C to this Part on subjective testing.
3.d.	**Motion system repeatability**	± 0.05 g actual platform linear accelerations.	None.				✓	✓	This test ensures that the motion system hardware and software (in normal FSTD operating mode) continue to perform as originally qualified. Performance changes from the original baseline can be readily identified with this information. See paragraph 3.5.5 of this Appendix.
3.e.	**Motion cueing fidelity**								Appropriate testing criterion and tolerances are currently being tested and evaluated throu.gh the ICFQ mechanism (refer to Appendix D to this Part).
3.e.	1) Motion cueing fidelity — Frequency-domain criterion.	To be defined.	Ground and in flight.				✓	✓	For the motion system as applied during training, record the combined modulus and phase of the motion cueing algorithm and motion platform over the frequency range appropriate to the characteristics of the helicopter being simulated. This test is only required during the initial FSTD qualification. See paragraph 3.5.6.1 of this Appendix.
3.e.	2) Motion cueing fidelity — Time-domain criterion.	To be defined.	Ground and in flight.				✓	✓	See paragraph 3.5.6.2 of this Appendix.

	TEST	TOLERANCE	FLIGHT CONDITION	TYPE I	TYPE II	TYPE III	TYPE IV	TYPE V	COMMENTS
3bis.	**VIBRATIONS**								
3bis. a.	**Characteristic motion vibrations**	None.	Ground and in flight.						The following tests with recorded results and an SOC are required for characteristic motion vibrations, which can be sensed in the cockpit where applicable for the helicopter type. Vibrations tests results to include 1/Rev and n/Rev vibrations where n is the number of rotor blades. *Note.— "n/Rev" means a vibration test for the frequency equal to n times the rotor RPM.* The recorded test results for characteristic buffets should allow the comparison of relative amplitude versus frequency. Tests are required with recorded results which allow the comparison of relative amplitudes versus frequency in the longitudinal, lateral and vertical axes with helicopter data. Steady state tests are acceptable. For type III devices, only footprint test results are required. Where initial evaluation employs approved subjective tuning to develop the approved reference standard, tolerances should be used during recurrent evaluations.

	TEST	TOLERANCE	FLIGHT CONDITION	TYPE I	TYPE II	TYPE III	TYPE IV	TYPE V	COMMENTS
3bis. a.	1) Ground.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Ground.			✓	✓	✓	Tests to demonstrate the normal vibration level with helicopter on the ground, all engines operating at normal idle and flight power settings. Two tests conditions are required: 1) engine(s) control(s) on “Idle” power setting and corresponding N_R condition; and 2) engine(s) control(s) on “Flight” power setting and corresponding N_R condition.
3bis. a.	2) Hover (IGE).	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Hover.			✓	✓	✓	Test to demonstrate the normal vibration level with helicopter in hover condition IGE.
3bis. a.	3) Hover (OGE).	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Hover.			✓	✓	✓	Test to demonstrate the normal vibration level with helicopter in hover condition OGE.
3bis. a.	4) Normal climb.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Climb.			✓	✓	✓	Test to demonstrate the normal vibration level with helicopter in normal climb at normal climb speed, all engines operating.
3bis. a.	5) Vertical climb.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Climb.			✓	✓	✓	Test to demonstrate the normal vibration level with helicopter in vertical climb from a hover condition.

	TEST	TOLERANCE	FLIGHT CONDITION	TYPE I	TYPE II	TYPE III	TYPE IV	TYPE V	COMMENTS
3bis. a.	6) Level flight at low speed.	+ 3 db/ - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Cruise.			✓	✓	✓	Test to demonstrate the normal vibration level with helicopter in forward translational level flight around V_y.
3bis. a.	7) Level flight at cruise speed.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Cruise.			✓	✓	✓	Test to demonstrate the normal vibration level with helicopter in flight at normal cruise speed.
3bis. a.	8) Level flight at high speed.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Cruise.			✓	✓	✓	Test to demonstrate the normal vibration level with helicopter in flight at high speed (near or at V_{ne}).
3bis. a.	9) Descent.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Descent.			✓	✓	✓	Test to demonstrate the normal vibration level with helicopter in normal powered descent at normal speed, all engines operating.
3bis. a.	10) Autorotation.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Autorotation.			✓	✓	✓	Test to demonstrate the normal vibration level with helicopter in autorotation descent, all engines inoperative (or at least at idle), nominal main rotor RPM and recommended autorotation speed.

	TEST	TOLERANCE	FLIGHT CONDITION	TYPE I	TYPE II	TYPE III	TYPE IV	TYPE V	COMMENTS
3bis. a.	11) Steady state turns.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Cruise.			✓	✓	✓	Test to demonstrate the normal vibration level with helicopter in stabilized turn at various bank angles; at least two conditions are to be demonstrated (for instance for a standard rate of turn and a higher bank angle of around 45° in order to demonstrate the effect of rotor disk load on vibration level, if any).
3bis. b.	**Special conditions.**	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend.	Ground and in flight.				✓	✓	This applies to special steady-state cases identified as particularly significant to the pilot, important in training, or unique to a specific helicopter type or model. This may include effect of landing gear, icing effect, vortex ring state (settling with power), atmospheric disturbance and all relevant vibration cues due to normal and abnormal operations of the rotor and transmission system. The recorded test results for characteristic buffets should allow the comparison of relative amplitude versus frequency. An SOC is required. Tests are required with recorded results that allow the comparison of relative amplitudes versus frequency in the longitudinal, lateral and vertical axes with helicopter data. Steady state tests are acceptable. Where initial evaluation employs approved subjective tuning to develop the approved reference standard, tolerances should be used during recurrent evaluations. For atmospheric disturbance, general purpose models are acceptable which approximate demonstrable flight test data.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.	**VISUAL SYSTEM**								
4.a.	**Visual scene quality**								
4.a.1	Continuous field of view.	Visual display providing each pilot simultaneously with a minimum of 210° horizontal and 60° vertical continuous field of view. With the image centred on the helicopter centreline the offset from each pilot's eye position should not exceed 10 degrees inboard.	Not applicable.		✓	✓	✓	✓	The field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of 5° squares. Installed alignment should be confirmed in an SOC (this would generally be results from acceptance testing). The 10 degrees limitation may be extended to 12 degrees where practical considerations, such as dome size on large dual cockpit helicopters, make the increase necessary, provided that the FSTD operator can prove to the satisfaction of the qualifying authority that the quality of training will not be compromised.
(ctd)	Continuous field of view, but a reduced field of view is acceptable in accordance with the intended use of the device.	Visual display providing each pilot simultaneously with a minimum of 180° horizontal and 45° vertical continuous field of view or reduced field of view as agreed for the device. With the image centred on the helicopter centreline the offset from each	Not applicable.						The field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of 5° squares. Installed alignment and agreed field of view should be confirmed in an SOC (this would generally be results from acceptance testing). The 10 degrees limitation may be extended to 12 degrees where practical considerations, such as dome size on large dual cockpit helicopters, make the increase necessary, provided that the FSTD operator can prove to the satisfaction of the qualifying

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		pilot's eye position should not exceed 10 degrees inboard.							authority that the quality of training will not be compromised.
4.a.1	Display field of view.	Visual field of view for each pilot of a minimum of 45° horizontally and 30° vertically, unless restricted by the type of helicopter, simultaneously for each pilot. With the image centred on the helicopter centreline the offset from each pilot's eye position should not exceed 10 degrees inboard.	Not applicable.	✓					The minimum distance from the pilot's eye position to the surface of a direct view display may not be less than the distance to any front panel instrument. A 30° vertical field of view may be insufficient to meet the requirements of the visual ground segment (if required). This needs to be considered in the FOV calculation. The 10 degrees limitation may be extended to 12 degrees where practical considerations, such as dome size on large dual cockpit helicopters, make the increase necessary, provided that the FSTD operator can prove to the satisfaction of the qualifying authority that the quality of training will not be compromised.
4.a.2.a.1	System geometry — Image position.	From each eyepoint position, the centre of the image is between 0° and 2° inboard in the horizontal plane with the image centred on the helicopter centreline and within ± 0.25° vertically <u>for collimated displays</u>. (ctd on next page)	Not applicable.		✓	✓	✓	✓	The image position should be checked relative to the FSTD centreline. Where there is a design offset in the vertical display centre this should be stated.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		For real image displays, from each eyepoint position, the centre of the image is between 0° and 10° inboard in the horizontal plane with the image centred on the helicopter centreline and within ± 0.25° vertically and ± 0.5° horizontally.							
4.a.2.a.2	System geometry — Absolute geometry.	Within the specified minimum FOV all points on a 5° grid should fall within 3° of the design position as measured from each pilot eyepoint, when the image is aligned with the relevant eyepoint.	Not applicable.		✓	✓	✓	✓	Where a system with more than the minimum FOV is supplied, the geometry outside the central area should not have any distracting discontinuities.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.a.2.a.3	System geometry — Relative geometry.	Measurements of relative dot positions should be made every 5 degrees. In the area from -10° to the lowest visible point, at 15° azimuth inboard, 0°, 30°, 60° and 85° degrees azimuth outboard for each pilot position, vertical measurements should be made every 1° to the edge of the visible image. The relative position from one point to the next should not exceed within Zone 1: 0.075°/degree; Zone 2: 0.15°/degree; and Zone 3: 0.2°/degree.	Not applicable.		✓	✓	✓	✓	For a diagram showing Zones 1, 2 and 3 and further discussion of this test, see paragraph 3.6.3.3 of this Appendix. *Note.— A means to perform this check with a simple go/no go gauge is encouraged for recurrent testing.*
4.a.2.b		The geometry of the image should have no distracting discontinuities.		✓					

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.a.3	Surface resolution (object detection).	Not greater than 2 arc minutes.	Not applicable.		✓	✓	✓	✓	Resolution will be demonstrated by a test of objects shown to occupy the required visual angle in each visual display used on a scene from the pilot's eyepoint. The object will subtend 2 arc minutes to the eye. This may be demonstrated using threshold bars for a horizontal test. A vertical test should also be demonstrated. The subtended angles should be confirmed by calculations in an SOC.
	Surface resolution (object detection).	Not greater than 3 arc minutes.	Not applicable.						Resolution will be demonstrated by a test of objects shown to occupy the required visual angle in each visual display used on a scene from the pilot's eyepoint. The object will subtend 3 arc minutes to the eye. This may be demonstrated using threshold bars for a horizontal test. A vertical test should also be demonstrated. The subtended angles should be confirmed by calculations in an SOC.
	Surface resolution (object detection).	Not greater than 4 arc minutes.	Not applicable.	✓					Resolution will be demonstrated by a test of objects shown to occupy the required visual angle in each visual display used on a scene from the pilot's eyepoint. The object will subtend 4 arc minutes to the eye. This may be demonstrated using threshold bars for a horizontal test. A vertical test should also be demonstrated. The subtended angles should be confirmed by calculations in an SOC.
4.a.4	Light-point size.	Not greater than 5 arc minutes.	Not applicable.		✓	✓	✓	✓	Light-point size should be measured using a test pattern consisting of a single row of light-points displayed as both a horizontal and vertical row. It should be possible to move the light-points relative to the eyepoint in all axes. At a point where modulation is just discernible in each visual channel a calculation should be made to determine the light spacing. An SOC is required to state test method and calculation.
	Light-point size.	Not greater than 8 arc minutes.	Not applicable.	✓					

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.a.5	Raster surface contrast ratio.	Not less than 8:1.	Not applicable.		✓	✓	✓	✓	Surface contrast ratio should be measured using a raster drawn test pattern filling the entire visual scene (all channels). The test pattern should consist of black and white squares, of not more than 10° per square, with a white square in the centre of each channel. Measurements should be made of the bright squares using a 1° spot photometer and the average calculated. This value should have a minimum brightness of 7 cd/m^2 (2 ft-lamberts). Measure the dark squares. The contrast ratio is the average of the bright square value divided by the average of the dark square value. *Note 1.— During contrast ratio testing, FSTD aft cabin and cockpit ambient light levels should be as low as possible.* *Note 2 — Measurements should be taken at the centre of squares to avoid light spill into the measurement device.*
	Raster surface contrast ratio.	Not less than 5:1.	Not applicable.						Surface contrast ratio should be measured using a raster drawn test pattern filling the entire visual scene (all channels). The test pattern should consist of black and white squares, 5° per square with a white square in the centre of each channel. Measurement should be made on the centre bright square for each channel using a 1° spot photometer. This value should have a minimum brightness of 7 cd/m^2 (2 ft-lamberts). Measure any adjacent dark squares. The contrast ratio is the bright square value divided by the dark square value.
	Raster surface contrast ratio. (ctd on next page)	Not less than 4:1.	Not applicable.	✓					

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
									Note 1.— During contrast ratio testing, FSTD aft cabin and cockpit ambient light levels should be as low as possible. *Note 2.— Measurements should be taken at the centre of squares to avoid light spill into the measurement device.*
4.a.6	Light-point contrast ratio.	Not less than 25:1.	Not applicable.		✓	✓	✓	✓	Light-point contrast ratio should be measured using a test pattern demonstrating an area of greater than 1° area filled with white light-points and should be compared to the adjacent background. *Note.— Light-point modulation should be just discernible on calligraphic systems but will not be discernable on raster systems.* Measurements of the background should be taken such that the bright square is just out of the light meter FOV. *Note.— During contrast ratio testing, FSTD aft cabin and cockpit ambient light levels should be as low as practical.*
	Light-point contrast ratio.	Not less than 10:1.	Not applicable.						
	Light-point contrast ratio.	Not less than 8:1.	Not applicable.	✓					
4.a.7	Light-point brightness.	Not less than 30 cd/m^2 (8.8 ft-lamberts).	Not applicable.		✓	✓	✓	✓	Light-points should be displayed as a matrix creating a square. On calligraphic systems the light-points should just merge. On raster systems the light-points should overlap such that the square is continuous (individual light-points will not be visible).
	Light-point brightness.	Not less than 20 cd/m^2 (5.8 ft-lamberts).	Not applicable.						

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.a.8	Surface brightness.	Not less than 20 cd/m^2 (5.8 ft-lamberts) on the display.	Not applicable.		✓	✓	✓	✓	Surface brightness should be measured on a white raster and measuring the brightness using the 1° spot photometer. Light-points are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable.
	Surface brightness.	Not less than 14 cd/m^2 (4.1 ft-lamberts) on the display.	Not applicable.						
4.a.9	Black level and sequential contrast.	Black intensity: Black polygon brightness — ambient brightness < 0.015 cd/m^2 (0.004 ft-lamberts). Sequential contrast: White polygon brightness / (black polygon brightness — ambient brightness) > 2 000:1.	Not applicable.		✓	✓	✓	✓	The light meter should be mounted in a fixed position viewing the forward centre area of each display. All projectors should be turned off and the cockpit environment made as dark as possible. A reading should be taken of the remaining ambient light on the screen. The projectors should then be turned on and a black polygon displayed. A second reading should then be taken and the difference between this and the ambient level recorded. A full brightness white polygon should then be measured for the sequential contrast test. This test is generally only required for **light valve projectors**. An SOC should be provided if the test is not run, stating why.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.a. 10	Motion blur.	Modulation between white squares should be visible on gaps of 3 arc min or less when the pattern is rotated at 10°/s.	Not applicable.		✓	✓	✓	✓	A test pattern consisting of an array of five peak white squares with black gaps between them of decreasing width. The range of black gap widths should at least extend above and below the required detectable gap, and be in steps of 1 arc min. The peak white squares should be four times wider than the black gap width to avoid temporal aliasing. The pattern is rotated at the required rate. Two arrays of squares should be provided, one rotating in heading and the other in pitch, to provide testing in both axes. A series of stationary numbers identifies the size of the gaps. *Note.— This test can be limited by the display technology. Where this is the case the NAA should be consulted on the limitations.* This test is generally only required for **light valve projectors**. An SOC should be provided if the test is not run, stating why.
4.a. 11	Speckle test.	Speckle contrast should be <10%.	Not applicable.		✓	✓	✓	✓	An SOC is required describing the test method. This test is generally only required for **laser projectors**. An SOC should be provided if the test is not run, stating why.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.a. 12	Black level in stimulated NVG training (Type 3 EFVS device only (refer to Attachment L to this Part)).	Black polygon brightness <= 0.001 cd/m² (0.0003 ft-lambert).	Not applicable.		✓	✓	✓	✓	The test should be conducted with the visible OTW image projectors operating normally. The IR projectors should be turned off for this test. In cases where only one projector system is used for the OTW and the NVG image stimulation, the test should be conducted with this projector in NVG mode, i.e. with appropriate filtering. The light meter should be mounted in a fixed position viewing the forward centre area of each display. All projectors should be turned off and the cockpit environment made as dark as possible. A reading should be taken of the remaining ambient light on the screen. The OTW projectors should then be turned on and a black polygon displayed, a second reading should then be taken and the difference between this and the ambient level recorded.
4.a. 13	Light-point brightness in stimulated NVG training (Type 3 EFVS device only (refer to Attachment L to this Part)).	Not less than 10 cd/m^2 (2.9 ft-lamberts).	Not applicable.		✓	✓	✓	✓	The test should be conducted with the IR projectors operating normally. The visible OTW image projectors should be turned off for this test. In cases where only one projector system is used for the OTW and the NVG image stimulation, the test should be conducted with this projector in NVG mode, i.e. with appropriate filtering. Light-points should be displayed as a matrix creating a square. On calligraphic systems the light-points should just merge. On raster systems the light-points should overlap such that the square is continuous (individual lights will not be visible).

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.b	**Head-Up Display (HUD)**								
4.b.1	Static alignment.	Static alignment with displayed image. HUD bore sight should align with the centre of the displayed image spherical pattern. Tolerance ± 6 arc min.			✓	✓	✓	✓	Alignment applies to the pilot flying only.
4.b.2	System display	All functionality in all flight modes should be demonstrated.			✓	✓	✓	✓	A statement of the system capabilities should be provided and the capabilities demonstrated.
4.b.3	HUD attitude vs FSTD attitude indicator (pitch and roll of horizon).	Pitch and roll align with the helicopter instruments and OTW display. Tolerance ± 1°.	In flight.		✓	✓	✓	✓	Alignment applies to the pilot flying only.
4.c	**Enhanced flight vision system (EFVS)**								
4.c.1	Registration test.	Alignment between EFVS display and OTW image should represent the alignment typical of the helicopter and system type.	Take-off point and on approach at 61 m (200 ft) AGL.		✓	✓	✓	✓	*Note.— The effects of the alignment tolerance in 4.b.1 should be taken into account.*
	Registration test.	Alignment between EFVS display and OTW image should represent the alignment typical of the helicopter and system type.	Take-off point and on approach at 61 m (200 ft) AGL.						Alignment applies to the pilot flying only. *Note.— The effects of the alignment tolerance in 4.b.1 should be taken into account.*

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.c.2	EFVS RVR and visibility calibration.	The scene represents the EFVS view at 350 m (1 200 ft) and 1 600 m (1 sm) RVR including correct light intensity.	In flight.		✓	✓	✓	✓	IR scene representative of both 350 m (1 200 ft), and 1 600 m (1 sm). Visual scene may be removed.
4.c.3	Thermal crossover.	Demonstrate thermal crossover effects during day to night transition.	Day and night.		✓	✓	✓	✓	The scene will correctly represent the thermal characteristics of the scene during a day to night transition.
4.d	**Visual ground segment**								
4.d.1	Visual ground segment. This test applies only to helicopters equipped with ILS. Where the straight ahead down view of the helicopter exceeds the display system downward FOV, the display down view angle should be used for the test.	Near end: the correct number of approach lights within the computed VGS should be visible. Far end: ± 20% of the computed VGS. Where the threshold lights are computed to be visible they should be visible in the FSTD.	Trimmed in the landing configuration at 30 m (100 ft) wheel/skid height above touchdown zone on glide slope at an RVR setting of 300 m (1 000 ft) or 350 m (1 200 ft).		✓	✓	✓	✓	This test is designed to assess items impacting the accuracy of the visual scene presented to a pilot at DH on an ILS approach. These items include: 1) RVR/Visibility; 2) glide slope (G/S) and localizer modelling accuracy (location and slope) for an ILS; 3) for a given mass, configuration and speed representative of a point within the helicopter's operational envelope for a normal approach and landing; and 4) radio altimeter. For non type-specific devices, a cut-off angle typical of the group of helicopters should be used. *Note.— If non-homogeneous fog is used, the vertical variation in horizontal visibility should be described and included in the slant range visibility calculation used in the VGS computation.*

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
4.e	**Visual system scene content**								
4.e.1	System content — Day, dusk and night.	Not less than: 10 000 visible textured surfaces, 5 000 light-points, 16 moving models.	Not applicable.		✓	✓	✓	✓	Demonstrated through use of a visual scene rendered with the same image generator modes used to produce scenes for training. The required surfaces, light-points and moving models should be displayed simultaneously. The stated capacity should be available in all time of day conditions.
4.e.2	System content — Day, dusk and night.	Not less than: 6 000 visible textured surfaces, 5 000 light-points, 16 moving models.	Not applicable.						
4.e.3	System content — Day, dusk and night.	Not less than: 6 000 visible textured surfaces, 1 000 light-points.	Not applicable.	✓					

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
5.	**SOUND SYSTEM**								
5.a	**Basic requirements**								All Type IV and V tests in this section should be presented using an unweighted 1/3 octave band format from at least band 17 to 42 (50 Hz to 16 kHz). A measurement of minimum 20 s should be taken, when possible, at the location corresponding to the approved data set. The approved data set and FSTD results should be produced using comparable data analysis techniques. Refer to paragraph 3.7 of this Appendix. For Type III, tests in this section may be presented as a single overall SPL level.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
5.a.	1) Ready for engine start.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Ground.					✓	Normal condition prior to engine start. The APU should be on if appropriate. <u>For Type V</u>: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. <u>For Type V</u>: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.					✓		

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			
5.a.	2) All engines operating at normal idle power setting; a) rotor not turning (if applicable); and b) rotor turning.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Ground.					✓	For Type V: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For Type V: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. (ctd on next page)					✓		

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.							
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
5.a.	3) All engines operating at normal flight power setting.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Ground.					✓	Normal condition prior to lift-off. For Type V: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For Type V: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB. (ctd on next page)					✓		

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			
5.a.	4) Hover; a) IGE; and b) OGE.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Hover.					✓	For Type V: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For Type V: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. (ctd on next page)					✓		

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.							
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
5.a.	5) Climb.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	En-route climb.					✓	Medium altitude. <u>For Type V</u>: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. <u>For Type V</u>: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB. (ctd on next page)					✓		

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			
5.a.	6) Cruise.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB. (ctd on next page)	Cruise.					✓	Normal cruise configuration. For Type V: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For Type V: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.					✓		
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
5.a.	7) Steady state turn.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Cruise.					✓	30° to 45° bank angle. <u>For Type V</u>: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. <u>For Type V</u>: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB. (ctd on next page)					✓		

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			
5.a.	8) Autorotation.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Autorotation in steady descent.					✓	Normal operating RPM. <u>For Type V</u>: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. <u>For Type V</u>: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands					✓		

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.							
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			
5.a.	9) Final approach.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB. (ctd on next page)	Landing.					✓	Constant airspeed. For Type V: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For Type V: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.					✓		
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
5.b	**Special cases**	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.						✓	This applies to special steady-state cases identified as particularly significant to the pilot, important in training, or unique to a specific helicopter type or model. <u>For Type V</u>: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. <u>For Type V</u>: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations. All Type IV and V tests in this section should be presented using an unweighted 1/3 octave band format from at least bands 17 to 42 (50 Hz to 16 kHz). A measurement of minimum 20 s should be taken, when possible, at the location corresponding to the approved data set. The approved data set and FSTD results should be produced using comparable data analysis techniques. Refer to paragraph 3.7 of this Appendix.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB. (ctd on next page)					✓		

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			For Type III, tests in this section may be presented as a single overall SPL level.
5.c	**FSTD background noise**	Initial evaluation: background noise levels should fall below the plot in Figure B-6 of this Appendix. Recurrent evaluation: ± 3 dB per 1/3 octave band compared to initial evaluation.					✓	✓	Results of the background noise at initial qualification should be included in the QTG document and approved by the qualifying NAA. The simulated sound will be evaluated to ensure that the background noise does not interfere with training. Refer to paragraph 3.7.7 of this Appendix. The measurements are to be made with the simulation running, the sound muted and a dead cockpit. For Types IV and V, this test should be presented using an unweighted 1/3 octave band format from band 17 to 42 (50 Hz to 16 kHz). For Type III, this test may be presented as a single overall SPL level.
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
5.d	**Frequency response**	Initial evaluation: not applicable. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.					✓	✓	Only required if the results are to be used during recurrent evaluations according to paragraph 3.7.8 of this Appendix. The results should be acknowledged by the NAA during the initial qualification. For Types IV and V, this test should be presented using an unweighted 1/3 octave band format from band 17 to 42 (50 Hz to 16 kHz). For Type III, this test should be run at three frequencies (high, mid-range and low).
		Initial evaluation: not applicable. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓			

	TEST	TOLERANCE	FLIGHT CONDITION	Type I	Type II	Type III	Type IV	Type V	COMMENTS
6	**SYSTEMS INTEGRATION**								
6.a	**System response time**								
6.a.	1) Transport delay.	85 ms or less after controller movement.	Pitch, roll and yaw.			✓	✓	✓	One separate test is required in each axis. Where EFVS systems are installed, the EFVS response should be within ± 30 ms from visual system response, and not before motion system response. *Note.— The delay from the helicopter EFVS electronic elements should be added to the 30 ms tolerance before comparison with the visual system reference as described in Attachment G to this Part.*
		120 ms or less after controller movement.		✓	✓				

Appendix C

FUNCTIONS AND SUBJECTIVE TESTS

1. INTRODUCTION

1.1 Accurate replication of helicopter systems functions should be checked at each flight crew member position. This includes procedures using the RFM and checklists. Handling qualities, performance and FSTD systems operation, as they pertain to the actual helicopter, as well as FSTD cueing (e.g. visual, motion cueing) and other supporting systems (e.g. IOS), should be subjectively assessed. Prior coordination with the NAA responsible for the evaluation is essential to ensure that the functions tests are conducted in an efficient and timely manner and that any skills, experience or expertise required by the evaluation team are available.

1.2 The necessity of functions and subjective tests arises from the need to confirm that the simulation has produced a totally integrated and acceptable replication of the helicopter. Unlike the objective tests listed in Appendix B to this Part, the subjective testing should cover those areas of the flight envelope that may reasonably be reached by a trainee. Like the validation tests, the functions and subjective tests conducted during the initial evaluation are only a "spot check" and not a rigorous examination of the quality of the simulation in all areas of flight and systems operation. The operator should have completed the acceptance testing of the FSTD with support from the FSTD manufacturer prior to the device being submitted for the initial evaluation to be conducted by the NAA evaluator(s).

1.3 At the request of an operator, the FSTD may be assessed for a special aspect of a relevant training programme during the functions and subjective portion of an evaluation. Such an assessment may include a portion of a LOFT (line-oriented flight training) scenario, an operator/mission specific scenario or special emphasis items in the training programme. Unless directly related to a requirement for the current qualification type, the results of such an evaluation would not affect the FSTD's current status.

1.4 Functions tests should be run in a logical flight sequence at the same time as performance and handling assessments. This also permits the FSTD to run for two to three hours in real time, without repositioning of flight or position freeze, thereby permitting proof of reliability.

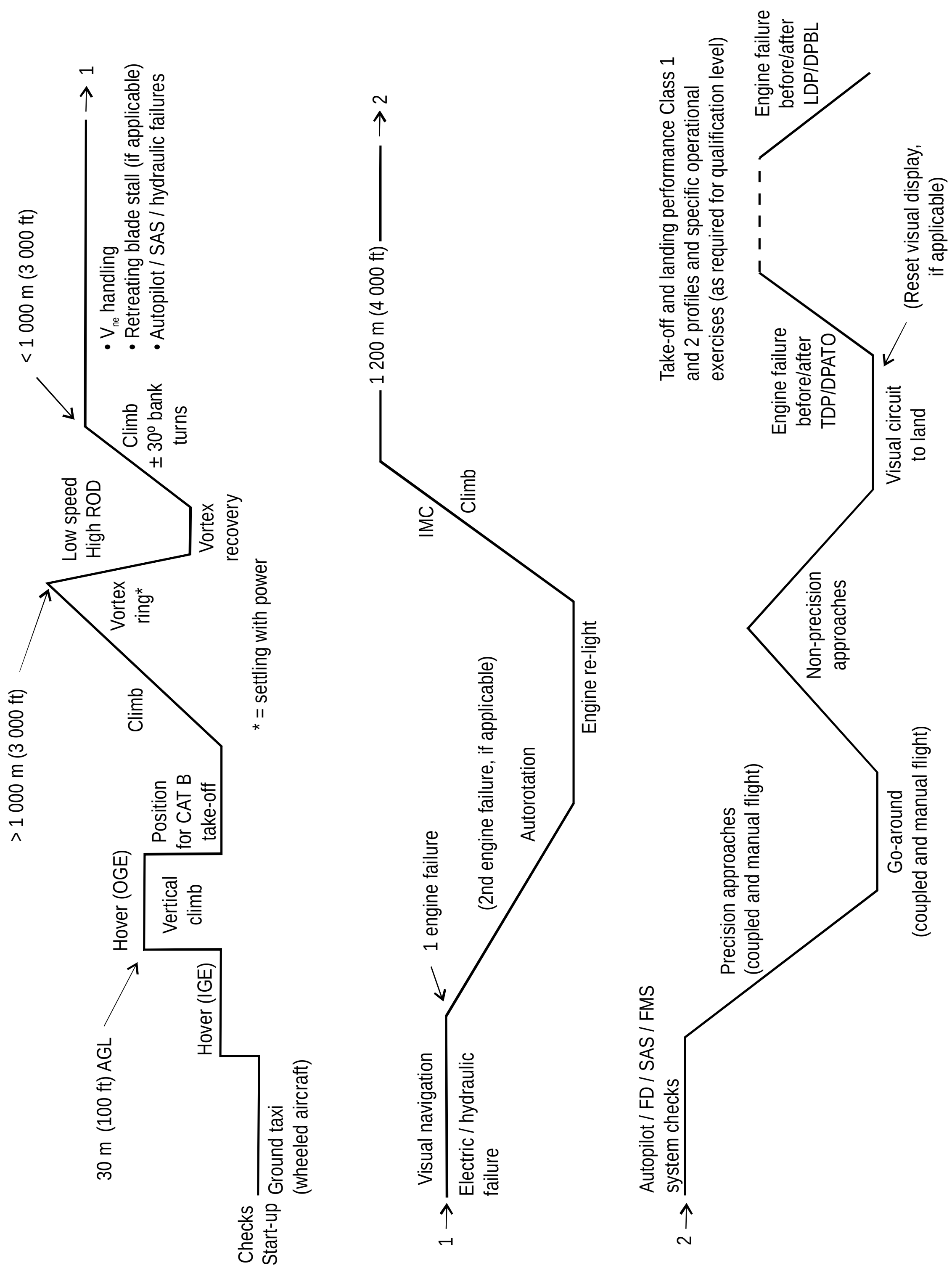
1.5 The FSTD should be assessed to ensure that repositions, resets and freezes support efficient and effective training.

2. TEST REQUIREMENTS

2.1 The ground and flight tests and other checks required for qualification are listed in the following Table of Functions and Subjective Tests. The table includes manoeuvres and procedures to ensure that the FSTD functions and performs appropriately for use in pilot training, testing and checking in the manoeuvres and procedures normally required of an approved training programme. It is understood that if a particular ground or flight test or other required check is not applicable to the helicopter being simulated or the operator's area of operations, the test or check is not required. There should not be any negative training aspects associated with any manoeuvre or procedure identified for any FSTD type for which several of the FSTD features are at a fidelity level of "R" or "G".

2.2 A representative selection of systems functions should be assessed for normal and, where appropriate, alternate operations. Normal, abnormal and emergency procedures associated with a flight phase should be assessed during the evaluation of manoeuvres or events within that flight phase. The effects of the selected malfunctions should be sufficient to correctly exercise the helicopter related procedures and checklists. Systems are listed separately under "any flight phase" to ensure appropriate attention to systems checks.

2.2 A typical Functions and Subjective Test Profile is shown below:


Checks
Start-up
Ground taxi
(wheeled aircraft)
Hover (IGE)
30 m (100 ft) AGL
Hover (OGE)
Vertical
climb
Position
for CAT B
take-off
> 1 000 m (3 000 ft)
Climb
Vortex
ring*
Low speed
High ROD
Vortex
recovery
Climb
± 30º bank
turns
< 1 000 m (3 000 ft)
• V_{ne} handling
• Retreating blade stall (if applicable)
• Autopilot / SAS / hydraulic failures
1
* = settling with power
1
Visual navigation
Electric / hydraulic
failure
1 engine failure
(2nd engine failure, if applicable)
Autorotation
Engine re-light
IMC
Climb
1 200 m (4 000 ft)
2
2
Autopilot / FD / SAS / FMS
system checks
Precision approaches
(coupled and manual flight)
Go-around
(coupled and manual flight)
Non-precision
approaches
Visual circuit
to land
(Reset visual display,
if applicable)
Engine failure
before/after
TDP/DPATO
Engine failure
before/after
LDP/DPBL
Take-off and landing performance Class 1
and 2 profiles and specific operational
exercises (as required for qualification level)

3. TABLE OF FUNCTIONS AND SUBJECTIVE TESTS

Note.— "Other" – means any other test, as applicable to the simulated helicopter and as applicable to the FSTD type.

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
1	**Preparation for flight.**					
1.a	Functional check. Accomplish a functions check of all switches, indicators, systems, and equipment at all crew members' and instructors' stations and determine that:					
1.a.1	The cockpit design and functions are identical to that of the helicopter.			✓	✓	✓
1.a.2	The cockpit design and functions are representative of the group of helicopter.	✓	✓			
1.a.3	The ambient lighting provides an even level of illumination and is not distracting to the flight crew members.	✓	✓	✓	✓	✓
2	**Surface operations (pre-take-off).**					
2.a	APU/Engine start and run-up.					
2.a.1	Normal start.	✓	✓	✓	✓	✓
2.a.2	Alternate start procedures.	✓	✓	✓	✓	✓
2.a.3	Abnormal starts and shutdowns (hot start, hung start, fire, etc.).	✓	✓	✓	✓	✓
2.a.4	Rotor start/engagement and acceleration, disengagement and deceleration.					
2.a.4.a	Rotor start/engagement and acceleration.	✓	✓	✓	✓	✓
2.a.4.b	Rotor disengagement and deceleration (needles split).	✓	✓	✓	✓	✓
2.a.4.c	Ground resonance (if applicable on type).			✓	✓	✓
2.a.4.d	Icy/slippery surface.			✓	✓	✓
2.a.5	After start systems checks (e.g. electrical, hydraulic, flight controls, autopilot, radios, lighting systems).	✓	✓	✓	✓	✓
2.b	Taxi — Ground.					
2.b.1	Collective lever/cyclic friction setting.	✓	✓	✓	✓	✓
2.b.2	Power required to taxi/cyclic input.			✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
2.b.3	Brakes operation (effectiveness/failure).		✓	✓	✓	✓
2.b.4	Ground handling.		✓	✓	✓	✓
2.b.5	Water taxi/handling/floats.			✓	✓	✓
2.b.6	Tail/nosewheel lock operation.	✓	✓	✓	✓	✓
2.b.7	Minimum radius turn.			✓	✓	✓
2.b.8	Taxi aids (e.g. moving map).			✓	✓	✓
2.b.9	Surface contaminants (water, snow, ice, sand, etc.).		✓	✓	✓	✓
2.b.10	Surface roughness.				✓	✓
2.b.11	Surface type (hard, soft, etc.).			✓	✓	✓
2.b.12	Other.					
2.c	Taxi — Hover/air/transit/translational flight.					
2.c.1	Lift-off characteristics with and without wind.		✓	✓	✓	✓
2.c.2	Hover characteristics, engine and flight instruments response. *Note.— Hovering modes should include SAS ON and OFF, height stability ON and OFF, cyclic trim ON and OFF.*					
2.c.2.a	In ground effect (IGE).		✓	✓	✓	✓
2.c.2.b	Out of ground effect (OGE).		✓	✓	✓	✓
2.c.2.c	With and without wind.					
2.c.3	Hover power check.					
2.c.3.a	In ground effect (IGE).		✓	✓	✓	✓
2.c.3.b	Out of ground effect (OGE).		✓	✓	✓	✓
2.c.4	Hover turns (around a spot, about the nose/tail).		✓	✓	✓	✓
2.c.5	Anti-torque/directional control effect.		✓	✓	✓	✓
2.c.6	Translating tendency.		✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
2.c.7	No wind/headwind/crosswind/tailwind hover.		✓	✓	✓	✓
2.c.8	Critical azimuth.			✓	✓	✓
2.c.9	Air taxi/transit/translational flight (forward, sideward, rearward).		✓	✓	✓	✓
3	**Take-off and departure.**					
3.a	Normal.					
3.a.1	From ground.		✓	✓	✓	✓
3.a.2	From hover.					
3.a.2.a	CAT A and/or PC1/PC2 for all certified profiles.			✓	✓	✓
3.a.2.b	CAT B or PC3.		✓	✓	✓	✓
3.b	Running.			✓	✓	✓
3.c	Crosswind/tailwind.		✓	✓	✓	✓
3.d	Maximum performance.		✓	✓	✓	✓
3.e	MCTM.		✓	✓	✓	✓
3.f	Instrument.	✓	✓	✓	✓	✓
3.g	Confined area.		✓	✓	✓	✓
3.h	Slope.			✓	✓	✓
3.i	Obstacle clearance.		✓	✓	✓	✓
3.j	Elevated heliport/helideck/pinnacle/platform.		✓	✓	✓	✓
3.k	Vertical.		✓	✓	✓	✓
3.l	High altitude.		✓	✓	✓	✓
3.m	Take-off in snow, sand, dust.		✓	✓	✓	✓
3.n	Transition into forward flight.		✓	✓	✓	✓
3.o	Abnormal/emergency procedure during take-off and departure.					
3.o.1	Engine failure.			✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
3.o.2	Rejected take-off/forced landing.					
3.o.2.a	Over land.		✓	✓	✓	✓
3.o.2.b	Over water.		✓	✓	✓	✓
3.o.3	CAT A and/or PC1/PC2.					
3.o.3.a	Engine failure prior to TDP.			✓	✓	✓
3.o.3.b	Engine failure at or after TDP.		✓	✓	✓	✓
3.p	Instrument departure.	✓	✓	✓	✓	✓
3.q	Other.					
4	**Climb.**					
4.a	Normal.	✓	✓	✓	✓	✓
4.b	Obstacle clearance.		✓	✓	✓	✓
4.c	Best rate.	✓	✓	✓	✓	✓
4.d	Best angle.	✓	✓	✓	✓	✓
4.e	Vertical climb.		✓	✓	✓	✓
4.f	One (or more) engine(s) inoperative.		✓	✓	✓	✓
4.g	Level-off.	✓	✓	✓	✓	✓
4.h	CAT A and/or PC1/PC2 operation for all certified profiles with engine failure up to 300 m (1 000 ft) above heliport elevation.		✓	✓	✓	✓
4.i	Other.					
5	**Cruise.**					
5.a	Performance characteristics and flying qualities.					
5.a.1	Straight and level flight.	✓	✓	✓	✓	✓
5.a.2	Low speed flight (not below ETL speed).	✓	✓	✓	✓	✓
5.a.3	Accelerations and decelerations.	✓	✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
5.a.4	High speed vibrations.			✓	✓	✓
5.a.5	High speed warnings.			✓	✓	✓
5.a.6	Turns.					
5.a.6.a	Normal.	✓	✓	✓	✓	✓
5.a.6.b	Standard rates (rate 1/2, 1 and 2).	✓	✓	✓	✓	✓
5.a.6.c	Steep (30° and 45° of bank).	✓	✓	✓	✓	✓
5.a.6.d	Flight controls servo actuator transparency effects.			✓	✓	✓
5.b	En-route navigation.					
5.b.1	Terrain accuracy for forced landing area selection.		✓	✓	✓	✓
5.b.2	Terrain accuracy for visual navigation.		✓	✓	✓	✓
5.b.3	Radio navigation.	✓	✓	✓	✓	✓
6	**Descent and arrival.**					
6.a	Normal descent.	✓	✓	✓	✓	✓
6.b	Maximum rate descent/non-emergency autorotation (VFR and IFR).	✓	✓	✓	✓	✓
6.c	Autorotative descent.					
6.c.1	Straight-in.			✓	✓	✓
6.c.2	With turn.			✓	✓	✓
6.c.3	IMC.			✓	✓	✓
6.c.4	To landing.					✓
6.c.5	Power recovery.			✓	✓	✓
6.d	Instrument arrival.	✓	✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
7	**Instrument approaches and landing.** Only those instrument approach and landing tests relevant to the simulated helicopter type or systems should be selected from the following list, where tests should be made with limiting wind velocities and with relevant system failures.					
7.a	Precision approach down to decision height/altitude.					
7.a.1	All engines operating.	✓	✓	✓	✓	✓
7.a.2	One (or more) engine(s) inoperative.	✓	✓	✓	✓	✓
7.a.3	Autopilot coupled approach (3, 4 axis).	✓	✓	✓	✓	✓
7.a.4	Manual approach with FD guidance.	✓	✓	✓	✓	✓
7.a.5	Manual approach without FD guidance (raw data).	✓	✓	✓	✓	✓
7.a.6	With HUD/EFVS.		✓	✓	✓	✓
7.a.7	Approach procedures.					
7.a.7.a	ILS.					
7.a.7.a.1	CAT I published approaches.	✓	✓	✓	✓	✓
7.a.7.a.2	CAT II published approaches.			✓	✓	✓
7.a.7.b	DGPS/GLS.	✓	✓	✓	✓	✓
7.a.7.c	Other.					
7.b	Non-precision approach down to MDA/H.					
7.b.1	All engines operating.	✓	✓	✓	✓	✓
7.b.2	One (or more) engine(s) inoperative.	✓	✓	✓	✓	✓
7.b.3	Autopilot coupled approach (3, 4 axis).	✓	✓	✓	✓	✓
7.b.4	Manual approach with FD guidance.	✓	✓	✓	✓	✓
7.b.5	Manual approach without FD guidance (raw data).	✓	✓	✓	✓	✓
7.b.6	With HUD/EFVS.		✓	✓	✓	✓
7.b.7	Approach procedures.					

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
7.b.7.a	ARA.		✓	✓	✓	✓
7.b.7.b	NDB.	✓	✓	✓	✓	✓
7.b.7.c	VOR, VOR/DME, TACAN.	✓	✓	✓	✓	✓
7.b.7.d	RNAV/RNP/GNSS/RNP APCH, RNP AR APCH, PINS.	✓	✓	✓	✓	✓
7.b.7.e	ILS LLZ (LOC), LLZ back course (or LOC-BC).	✓	✓	✓	✓	✓
7.b.7.f	ILS offset localizer/SDF (Simplified Directional Facility).	✓	✓	✓	✓	✓
7.b.7.g	Circling (approach prior to visual circling manoeuvre).	✓	✓	✓	✓	✓
7.c	Missed approach (including at MAPt).					
7.c.1	All engines operating, manual and autopilot coupled.	✓	✓	✓	✓	✓
7.c.2	One (or more) engine(s) inoperative, manual and autopilot coupled.	✓	✓	✓	✓	✓
7.c.3	With autopilot/stability augmentation system failure.			✓	✓	✓
8	**Visual approaches.**					
8.a	Normal.		✓	✓	✓	✓
8.b	Steep.		✓	✓	✓	✓
8.c	Shallow.		✓	✓	✓	✓
8.d	Vertical.		✓	✓	✓	✓
8.e	Elevated landing sites/pinnacle/ridgelines/slope.		✓	✓	✓	✓
8.f	Helideck (ship)/rig.		✓	✓	✓	✓
8.g	Confined area.		✓	✓	✓	✓
8.h	Crosswind/tailwind.		✓	✓	✓	✓
8.i	Visual traffic pattern.		✓	✓	✓	✓
8.j	Visual circling to land manoeuvre after an instrument approach.		✓	✓	✓	✓
8.k	Quick stop.		✓	✓	✓	✓
8.l	Forced landing approach.		✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
8.m	Transition to hover		✓	✓	✓	✓
8.n	With HUD/EFVS.		✓	✓	✓	✓
8.o	Other.					
8.p	Balked landing.					
8.p.1	All engines operating.		✓	✓	✓	✓
8.p.2	One engine inoperative.		✓	✓	✓	✓
8.p.3	Balked rig/deck landing.		✓	✓	✓	✓
8.q	CAT A or PC1/PC2 operation for all certified profiles from 300 m (1 000 ft) above heliport elevation to or after LDP.		✓	✓	✓	✓
9	**Landing transition/touchdown.**					
9.a	From a hover.		✓	✓	✓	✓
9.b	Running.			✓	✓	✓
9.c	Slope.			✓	✓	✓
9.d	Surface (hard, soft, water).			✓	✓	✓
9.e	Crosswind/tailwind.		✓	✓	✓	✓
9.f	High altitude.		✓	✓	✓	✓
9.g	Snow/sand/dust/water spray.			✓	✓	✓
9.h	Elevated landing sites/pinnacle/ridgelines.		✓	✓	✓	✓
9.i	Helideck (ship)/rig.			✓	✓	✓
9.j	From a visual approach.		✓	✓	✓	✓
9.k	From an instrument approach to minimums and visual final approach thereafter.	✓	✓	✓	✓	✓
9.l	From autorotation.			✓	✓	✓
9.m	With anti-torque/directional control malfunction.			✓	✓	✓
9.n	Other.					

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
9.o	CAT A operation for all certified profiles (PC1/PC2).					
9.o.1	Landing with engine failure prior to LDP.		✓	✓	✓	✓
9.o.2	Landing with engine failure at or after LDP.		✓	✓	✓	✓
10	**Engine shutdown and parking.**					
10.a	Engine and systems operation.	✓	✓	✓	✓	✓
10.b	Parking brake operation.	✓	✓	✓	✓	✓
10.c	Rotor disengagement and deceleration.	✓	✓	✓	✓	✓
10.d	Rotor brake operation.	✓	✓	✓	✓	✓
10.e	Emergency evacuation.	✓	✓	✓	✓	✓
10.f	Other.					
11	**Any flight phase.**					
11.a	Helicopter and powerplant systems operation (where fitted) including associated abnormal and emergency procedures.					
11.a.1	Air conditioning and ventilation system.			✓	✓	✓
11.a.2	Autopilot and flight director.	✓	✓	✓	✓	✓
11.a.3	Stability and control augmentation system.	✓	✓	✓	✓	✓
11.a.4	Communications.	✓	✓	✓	✓	✓
11.a.5	Electrical system.	✓	✓	✓	✓	✓
11.a.6	Fire and smoke detection and suppression system.	✓	✓	✓	✓	✓
11.a.7	Flight controls.	✓	✓	✓	✓	✓
11.a.8	Flight control computers.	✓	✓	✓	✓	✓
11.a.9	Stabilizer/stabilator.	✓	✓	✓	✓	✓
11.a.10	Fuel and oil systems.	✓	✓	✓	✓	✓
11.a.11	Hydraulic system.	✓	✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
11.a.12	De-icing/anti-icing system.	✓	✓	✓	✓	✓
11.a.13	Landing gear including landing gear operating time and floats deployment.	✓	✓	✓	✓	✓
11.a.14	Lighting (internal and external).	✓	✓	✓	✓	✓
11.a.15	Oxygen system.			✓	✓	✓
11.a.16	Pneumatic system.	✓	✓	✓	✓	✓
11.a.17	Auxiliary engine/auxiliary power unit (APU).	✓	✓	✓	✓	✓
11.a.18	Engine.	✓	✓	✓	✓	✓
11.a.19	Transmission systems.	✓	✓	✓	✓	✓
11.a.20	Rotor systems.	✓	✓	✓	✓	✓
11.a.21	Airborne radar used for weather avoidance, offshore operations and approaches (ARA).			✓	✓	✓
11.a.22	Terrain awareness warning systems and airborne collision avoidance systems (e.g. HTAWS, EGPWS, GPWS, TCAS).			✓	✓	✓
11.a.23	Flight data display systems.	✓	✓	✓	✓	✓
11.a.24	Flight instruments system.	✓	✓	✓	✓	✓
11.a.25	Flight management systems.	✓	✓	✓	✓	✓
11.a.26	Head-up displays (including EFVS, if appropriate).		✓	✓	✓	✓
11.a.27	Navigation systems.	✓	✓	✓	✓	✓
11.a.28	Wind shear avoidance equipment.			✓	✓	✓
11.a.29	Electronic flight bag.		✓	✓	✓	✓
11.a.30	Automatic checklists (normal, abnormal and emergency procedures).	✓	✓	✓	✓	✓
11.a.31	Voice activated systems.	✓	✓	✓	✓	✓
11.a.32	Other.					

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
11.b	Airborne and other miscellaneous procedures.					
11.b.1	Holding.	✓	✓	✓	✓	✓
11.b.2	Air hazard avoidance (traffic, weather, including visual correlation).			✓	✓	✓
11.b.3	Mast bumping.		✓	✓	✓	✓
11.b.4	Inadvertent entry into IMC.		✓	✓	✓	✓
11.b.5	Recovery from unusual attitudes.	✓	✓	✓	✓	✓
11.b.6	Wind shear/microburst encounters.					✓
11.b.7	Airborne weather radar.			✓	✓	✓
11.b.8	Engine failure – restart.			✓	✓	✓
11.b.9	High altitude operations.			✓	✓	✓
11.b.10	Brake and tire failures.			✓	✓	✓
11.b.11	Other.					
11.c	Master matrix malfunctions (see Part I, Appendix C, paragraph 1.1).					
11.c.1	Stability augmentation malfunction in flight.	✓	✓	✓	✓	✓
11.c.2	Autopilot malfunction in flight.	✓	✓	✓	✓	✓
11.c.3	Engine fire on ground or in the hover.			✓	✓	✓
11.c.4	Engine fire in forward flight.	✓	✓	✓	✓	✓
11.c.5	Engine malfunctions.	✓	✓	✓	✓	✓
11.c.6	Airframe fire and smoke on ground or in the hover.			✓	✓	✓
11.c.7	Airframe fire and smoke in forward flight.	✓	✓	✓	✓	✓
11.c.8	Engine failure before CDP/rejected take-off.		✓	✓	✓	✓
11.c.9	Engine failure after CDP (multi-engine).		✓	✓	✓	✓
11.c.10	OEI instrument approaches and go-around.	✓	✓	✓	✓	✓
11.c.11	OEI instrument approaches and landing.			✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
11.c.12	Autorotation to engine off landing.				✓	✓
11.c.13	Incipient vortex ring/power settling at altitude.			✓	✓	✓
11.c.14	Incipient vortex ring/power settling on approach.			✓	✓	✓
11.c.15	Recovery from unusual attitudes.	✓	✓	✓	✓	✓
11.c.16	MGB/IGB/TRGB chip detector/oil pressure warning in the hover.		✓	✓	✓	✓
11.c.17	MGB/IGB/TRGB chip detector/oil pressure warning in forward flight.	✓	✓	✓	✓	✓
11.c.18	Hydraulic failure in the hover.			✓	✓	✓
11.c.19	Hydraulic failure in forward flight.	✓	✓	✓	✓	✓
11.c.20	Hydraulic jack stall (servo transparency).	✓	✓	✓	✓	✓
11.c.21	Instrumentation/indication failure VFR.	✓	✓	✓	✓	✓
11.c.22	Instrumentation/indication failure IFR.	✓	✓	✓	✓	✓
11.c.23	DC system failure.	✓	✓	✓	✓	✓
11.c.24	AC system failure.	✓	✓	✓	✓	✓
11.c.25	Battery failure.	✓	✓	✓	✓	✓
11.c.26	Total electrical failure.	✓	✓	✓	✓	✓
11.c.27	Fuel transfer failure.			✓	✓	✓
11.c.28	Fuel supply malfunction.			✓	✓	✓
11.c.29	Landing gear malfunction.			✓	✓	✓
11.c.30	Loss of TR effectiveness.			✓	✓	✓
11.c.31	TR drive failure in the hover.			✓	✓	✓
11.c.32	TR drive failure in forward flight.				✓	✓
11.c.33	TR control failure in the hover.			✓	✓	✓
11.c.34	TR control failure in forward flight.				✓	✓
11.c.35	Coupled control malfunction.			✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
11.c.36	Uncoupled control malfunction.			✓	✓	✓
11.c.37	Dynamic rollover.			✓	✓	✓
11.c.38	Severe vibration.			✓	✓	✓
11.c.39	Ground resonance.				✓	✓
11.c.40	Retreating blade stall.				✓	✓
11.c.41	Rotor and airframe icing.				✓	✓
11.c.42	Engine icing.	✓	✓	✓	✓	✓
11.c.43	Anti-icing system malfunctions.	✓	✓	✓	✓	✓
11.c.44	Ditching.			✓	✓	✓
11.c.45	FADEC failures.				✓	✓
11.c.46	Other.					
12	**Visual System.** This section is written in the context of the operator presenting models of real-world or fictitious airports and other landing areas, serviced by the helicopter type being simulated, for use in completion of the functions and subjective tests described in this appendix. The real-world models should also be airports and landing areas that are used regularly in the training programme(s). However, where the requirement for device type allows, the operator may elect to use demonstration models for use during the device initial qualification which need not be fully up-to-date nor replicate any particular airport (fictitious airport). Not all elements described in this section need to be found in a single airport/landing area scene. However, all of the elements described in this section should be found throughout a combination of the required airport/landing area model(s) described below. During recurrent evaluations, the NAA may select any visual scene used in the operator's training programme(s) for completion of the functions and subjective tests, provided these visual scenes were modelled with the features required.					
12.a	**Functional test content requirements.** The following are the minimum airport/landing area model content requirements to satisfy visual capability tests and provide suitable visual cues to allow completion of all functions and subjective tests described in this appendix. FSTD operators are encouraged to use the model content described below for the functions and subjective tests. *Note.— The term "landing area" used herein includes both prepared (e.g. airport pad, oil rig, hospital) and unprepared (e.g. confined area, pinnacle, slope) helicopter operations areas.*					

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
12.a.1	Airport/landing area scenes.					
12.a.1.a	A minimum of four (4) real-world airport/landing area models. Real-world models need to be consistent with published data used for helicopter operations and capable of demonstrating all the visual system features below. Each model should be acceptable to the operator's NAA and should be selectable from the IOS.					
12.a.1.a.1	At least one (1) specific airport.			✓	✓	✓
12.a.1.a.2	At least one (1) helicopter landing area situated on a substantially elevated surface with respect to the surrounding structures or terrain (e.g. building top, offshore oil rig).			✓	✓	✓
12.a.1.a.3	At least one (1) helicopter landing area that meets the definition of a confined landing area.			✓	✓	✓
12.a.1.a.4	At least one (1) helicopter landing area on a sloped surface where the slope is at least 2.5°.			✓	✓	✓
12.a.1.b	A minimum of one (1) representative airport model and one (1) helicopter landing area. These models should be acceptable to the operator's NAA and selectable from the IOS. *Note.— Real-world models need to be consistent with published data used for helicopter operations.*		✓			
12.a.1.c	A minimum of one (1) generic airport/heliport model. This model should be acceptable to the operator's NAA and selectable from the IOS. *Note.— Real-world models need to be consistent with published data used for helicopter operations.*	✓				
12.a.2	Visual scene fidelity.					
12.a.2.a	The visual scene should correctly represent the parts of the airport/landing area and its surroundings used in the training programme. Visual cues should enable assessment of the rate of change of height, height AGL, translational displacements and rates during take-off, low altitude/low airspeed manoeuvring, approach, hover and landing.			✓	✓	✓
12.a.2.b	The fidelity of the visual scene and visual cues should be sufficient for the flight crew to: • visually identify the airport/landing area; • determine the position of the simulated helicopter; • successfully accomplish take-offs, approaches, and landings; and • manoeuvre around the airport/landing area on the ground or in a hover/air taxi as necessary. Visual cues availability should enable the flight crew to assess the rate of change of height and translational displacements and rates, during take-off and landing.		✓			

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
12.a.2.c	Visual scenes with sufficient scene content for the flight crew to successfully accomplish take-offs, approaches and landings.	✓				
12.a.2.d	For cross-country flights, sufficient scene ground details to allow visual navigation using appropriate scale map, as dictated by the training programme and at typical altitudes over a sector length equal to 30 minutes at an average cruise speed.		✓	✓	✓	✓
12.a.3	Landing areas, runways and taxiways.					
12.a.3.a	The landing areas, airport runways and taxiways.			✓	✓	✓
12.a.3.b	Representative landing areas, runways and taxiways.		✓			
12.a.3.c	Generic landing areas, runways and taxiways.	✓				
12.a.4	If appropriate to the airport, two parallel runways and one crossing runway displayed simultaneously; at least two runways should be capable of being lit simultaneously.			✓	✓	✓
12.a.5	Helicopter landing areas and runway threshold elevations and locations should be modelled to provide correlation with helicopter systems (e.g. HUD, GPS, compass, altimeter).	✓	✓	✓	✓	✓
12.a.6	Slopes in landing areas, runways, taxiways, and ramp areas should not cause distracting or unrealistic effects, including pilot eyepoint height variation.		✓	✓	✓	✓
12.a.7	Helicopter landing area surface, markings and lighting.					
12.a.7.a	Landing area surface and markings for each helicopter landing area should include the following, if appropriate:					
12.a.7.a.1	Markings for standard heliport identification (“H” and location), other specific marking such as a hospital pad, aiming point and aiming circle, where appropriate, properly sized, coloured and oriented.		✓	✓	✓	✓
12.a.7.a.2	TLOF.		✓	✓	✓	✓
12.a.7.a.3	FATO designation markings, as appropriate (including design size, “D” value, weight limitations, etc., where appropriate).		✓	✓	✓	✓
12.a.7.a.4	Safety areas, OFS and LOS, as appropriate.		✓	✓	✓	✓
12.a.7.a.5	Signs as appropriate for model used.		✓	✓	✓	✓
12.a.7.a.6	Windsock that gives appropriate wind cues.	✓	✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
12.a.7.b	Lighting of appropriate colours for the helicopter landing area including the following:					
12.a.7.b.1	Landing direction.	✓	✓	✓	✓	✓
12.a.7.b.2	Raised and flush FATO, TLOF perimeter and flood lighting.		✓	✓	✓	✓
12.a.7.b.3	Windsock lighting.	✓	✓	✓	✓	✓
12.a.7.b.4	Visual approach aids.	✓	✓	✓	✓	✓
12.a.7.b.5	Approach lighting of appropriate colour.	✓	✓	✓	✓	✓
12.a.7.c	Taxiway and movement area and markings associated with the helicopter landing area:					
12.a.7.c.1	Taxiways/taxi routes.	✓	✓	✓	✓	✓
12.a.7.c.2	Aprons.		✓	✓	✓	✓
12.a.7.d	Taxiway lighting of appropriate colours, directionality, behaviour and spacing, associated with each pad:					
12.a.7.d.1	Taxiways/taxi routes.	✓	✓	✓	✓	✓
12.a.7.d.2	Aprons.		✓	✓	✓	✓
12.a.8	Airport surface, markings and lighting:					
12.a.8.a	Runway surface and markings for each "in-use" runway should include the following, if appropriate:					
12.a.8.a.1	Threshold markings.	✓	✓	✓	✓	✓
12.a.8.a.2	Runway numbers.	✓	✓	✓	✓	✓
12.a.8.a.3	Touchdown zone markings.	✓	✓	✓	✓	✓
12.a.8.a.4	Fixed distance markings.		✓	✓	✓	✓
12.a.8.a.5	Edge markings.		✓	✓	✓	✓
12.a.8.a.6	Centre line markings.	✓	✓	✓	✓	✓
12.a.8.a.7	Distance remaining signs.			✓	✓	✓
12.a.8.a.8	Signs at intersecting runways and taxiways.		✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
12.a.8.a.9	Windsock that gives appropriate wind cues.	✓	✓	✓	✓	✓
12.a.8.b	Lighting of appropriate colours for the runway in use including the following:					
12.a.8.b.1	Threshold lights.	✓	✓	✓	✓	✓
12.a.8.b.2	Edge lights.	✓	✓	✓	✓	✓
12.a.8.b.3	End lights.	✓	✓	✓	✓	✓
12.a.8.b.4	Centre line lights.	✓	✓	✓	✓	✓
12.a.8.b.5	Touchdown zone lights.	✓	✓	✓	✓	✓
12.a.8.b.6	Lead-off lights.		✓	✓	✓	✓
12.a.8.b.7	Appropriate visual landing aid(s) for that runway.		✓	✓	✓	✓
12.a.8.b.8	Appropriate approach lighting system for that runway.	✓	✓	✓	✓	✓
12.a.8.b.9	Windsock lighting.	✓	✓	✓	✓	✓
12.a.8.c	Taxiway surface and markings associated with each “in-use” runway:					
12.a.8.c.1	Edge markings.		✓	✓	✓	✓
12.a.8.c.2	Centre line markings.		✓	✓	✓	✓
12.a.8.c.3	Runway holding position markings.	✓	✓	✓	✓	✓
12.a.8.c.4	ILS critical area markings.		✓	✓	✓	✓
12.a.8.c.5	All taxiway markings, lighting, and signage to taxi, as a minimum, from a designated parking position to a designated runway and return, after landing on the designated runway, to a designated parking position; a low visibility taxi route (e.g. surface movement guidance control system, follow-me truck, daylight taxi lights) should also be demonstrated for those operations authorized in low visibilities. The designated runway and taxi routing should be consistent with that airport for operations in low visibilities.		✓	✓	✓	✓
12.a.8.d	Taxiway lighting of appropriate colours, directionality, behaviour and spacing, associated with each “in-use” runway:					
12.a.8.d.1	Edge lights.	✓	✓	✓	✓	✓
12.a.8.d.2	Centre line lights.	✓	✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
12.a.8.d.3	Runway holding position and ILS critical area lights.	✓	✓	✓	✓	✓
12.a.9	Required visual model correlation with other aspects of the airport and landing area environment simulation.					
12.a.9.a	The airport or helicopter landing area model should be properly aligned with the navigational aids that are associated with operations at the runway "in-use" or helicopter landing area.	✓	✓	✓	✓	✓
12.a.9.b	The simulation of runway or helicopter landing area contaminants should be correlated with the displayed runway surface and lighting.		✓	✓	✓	✓
12.a.10	Airport and helicopter landing area buildings, structures, objects and lighting.					
12.a.10.a	Buildings, structures and lighting:					
12.a.10.a.1	The airport or helicopter landing area buildings, structures, objects and lighting.			✓	✓	✓
12.a.10.a.2	Representative airport or helicopter landing area buildings, structures, objects and lighting.		✓			
12.a.10.a.3	Generic airport or helicopter landing area buildings, structures, objects and lighting.	✓				
12.a.10.b	Representative moving and static clutter (e.g. other helicopters and aeroplanes, power carts, tugs, fuel trucks).		✓	✓	✓	✓
12.a.10.c	Apron markings (e.g. hazard markings, lead-in lines), lighting and a marshaller.			✓	✓	✓
12.a.11	Terrain and obstacles.					
12.a.11.a	Terrain and obstacles within 46 km (25 NM) of the reference airport or helicopter landing area with appropriate colours and textures for the simulated area. This includes ground objects of sufficient number, appropriate size and perspective.			✓	✓	✓
12.a.11.b	Representative depiction of terrain and obstacles within 18.5 km (10 NM) of the reference airport or landing area with colours and textures, as appropriate.		✓			
12.a.11.c	Depiction of terrain topographical features within 9.25 km (5 NM) of the reference airport or landing area. A limited area flat world is acceptable.	✓				
12.a.11.d	General terrain characteristics: below 1 500 m (5 000 ft) visual scene with adequate terrain features to permit navigation by sole reference to visual landmarks according to appropriate charts (typically 1:500 000, 1:250 000, 1:100 000 scale mapping). Terrain contouring should be suitably represented.			✓	✓	✓
12.a.11.e	Buildings, trees or other vertical obstructions in the immediate vicinity of the landing area.		✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
12.a.11.f	Suspended wires in the immediate vicinity of the landing area.		✓	✓	✓	✓
12.a.12	Significant, identifiable natural and cultural features and moving airborne traffic.					
12.a.12.a	Significant, identifiable natural and cultural features within 46 km (25 NM) of the reference airport or helicopter landing area. *Note.— This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only to provide a reasonable facsimile of runway orientation.*			✓	✓	✓
12.a.12.b	Representative depiction of significant and identifiable natural and cultural features within 18.5 km (10 NM) of the reference airport or helicopter landing area. *Note.— This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only to provide a reasonable facsimile of runway orientation.*		✓			
12.a.12.c	Representative moving airborne traffic (including the capability to present air hazards – e.g. airborne traffic on a possible collision course).		✓	✓	✓	✓
12.b	Visual scene management.					
12.b.1	All landing area and airport runway, approach and taxiway lighting, and cultural feature lighting intensity for any approach should be capable of being set to six (6) different intensities (0 to 5); all visual scene light-points should fade into view appropriately in accordance with the environmental conditions set in the FSTD.		✓	✓	✓	✓
12.b.2	Airport runway, approach and taxiway lighting, helicopter landing area approach lighting and cultural feature lighting intensity for any approach should be set at an intensity representative of that used in training for the visibility set; all visual scene light-points should fade into view appropriately.	✓				
12.b.3	The directionality of strobe lights, approach lights, runway edge lights, visual landing aids, runway centre line lights, threshold lights, touchdown zone lights on the runway of intended landing and TLOF or FATO lights should be realistically replicated.	✓	✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
12.c	Visual feature recognition. *Note.— The following are the minimum distances at which landing areas and runway features should be visible. Distances are measured from the runway threshold or helicopter landing area to a helicopter aligned with the runway or helicopter landing area on an extended 3-degree glide slope in suitable simulated meteorological conditions. For circling approaches, all tests below apply both to the runway used for the initial approach and to the runway of intended landing.*					
12.c.1	For helicopter landing areas:					
12.c.1.a	Heliport definition, strobe lights, approach lights, from 4.8 km (3 sm).	✓	✓	✓	✓	✓
12.c.1.b	Visual approach aids lights (e.g. HAPI) through approach angles up to 12 degrees.	✓	✓	✓	✓	✓
12.c.1.c	Taxiway definition from 3.2 km (2 sm).	✓	✓	✓	✓	✓
12.c.1.d	Markings within range of landing lights for night or dusk and dawn scenes.	✓	✓	✓	✓	✓
12.c.1.e	Markings as required by the surface resolution test on day scenes.		✓	✓	✓	✓
12.c.1.f	Landing direction lights and raised FATO lights from 1.6 km (1 sm).		✓	✓	✓	✓
12.c.1.g	Flush mounted FATO lights, TLOF lights, and the lighted windsock from 800 m (0.5 sm).	✓	✓	✓	✓	✓
12.c.1.h	Hover taxiway lighting (yellow/blue/yellow cylinders) from TLOF.	✓	✓	✓	✓	✓
12.c.2	For runways:					
12.c.2.a	Runway definition, strobe lights, approach lights, and runway edge white lights from 8 km (5 sm) of the runway threshold.	✓	✓	✓	✓	✓
12.c.2.b	Visual approach aids lights (VASIS, PAPI, etc.) from 8 km (5 sm) of the runway threshold.			✓	✓	✓
12.c.2.c	Visual approach aids lights (VASIS, PAPI, etc.) from 4.8 km (3 sm) of the runway threshold.	✓	✓			
12.c.2.d	Runway centre line lights and taxiway definition from 4.8 km (3 sm).	✓	✓	✓	✓	✓
12.c.2.e	Threshold lights and touchdown zone lights from 3.2 km (2 sm).	✓	✓	✓	✓	✓
12.c.2.f	Runway markings within range of landing lights for night or dusk and dawn scenes.	✓	✓	✓	✓	✓
12.c.2.g	Runway markings as required by the surface resolution test on day scenes.		✓	✓	✓	✓
12.c.2.h	For circling approaches, the runway of intended landing and associated lighting should fade into view in a non-distracting manner.		✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
12.d	Selectable airport visual scene capability for:					
12.d.1	Night.	✓	✓	✓	✓	✓
12.d.2	Dusk or dawn.	✓	✓	✓	✓	✓
12.d.3	Day.	✓	✓	✓	✓	✓
12.d.4	Dynamic effects — the capability to present multiple ground and air hazards, such as an aeroplane or another helicopter crossing the active runway or converging airborne traffic, a supply ship in the vicinity of the oil rig when the helicopter is on final approach for landing, etc.; hazards should be selectable via controls at the instructor station.		✓	✓	✓	✓
12.d.5	Illusions — operational visual scenes which portray representative physical relationships known to cause landing illusions, for example, short runways, landing approaches over water, uphill or downhill runways, rising terrain on the approach path and unique topographic features. *Note.— Illusions may be demonstrated at a generic airport or at a specific airport.*			✓	✓	✓
12.e	Correlation with helicopter and associated equipment.					
12.e.1	Visual system compatibility with aerodynamic programming.	✓	✓	✓	✓	✓
12.e.2	Visual cues to relate to actual helicopter responses.	✓	✓	✓	✓	✓
12.e.3	Visual cues to enable assessing sink rate and depth perception during landings.		✓	✓	✓	✓
12.e.4	Accurate portrayal of environment relating to helicopter attitudes.	✓	✓	✓	✓	✓
12.e.5	The visual scene should correlate with integrated helicopter systems, where fitted (e.g. terrain, traffic and weather avoidance systems and HUD/EFVS).					
12.e.5.a	Weather radar returns should correlate with the visual scene.	✓	✓	✓	✓	✓
12.e.5.b	Radar equipment used for offshore operations (ARA) should provide appropriate returns simulation correlated with the visual scene.		✓	✓	✓	✓
12.e.5.c	Terrain awareness warning system (e.g. HTAWS, EGPWS, GPWS) should correlate with the visual scene.		✓	✓	✓	✓
12.e.5.d	Airborne collision avoidance systems (e.g. TCAS) should correlate with the visual scene.		✓	✓	✓	✓
12.e.6	The effect of rain removal devices should be provided (i.e. the reduction of rain defocus once activated).		✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
12.e.7	The visual effects for each visible, ownship, helicopter external light(s) should be provided – taxi, landing and search light lobes including independent operation.	✓	✓	✓	✓	✓
12.e.8	Dynamic visual representation of rotor blades and tip path including effects of rotor start-up and shutdown as well as orientation of the rotor disc due to pilot control input.		✓	✓	✓	✓
12.e.9	Visual representation of rotor blade tip path plane and orientation due to pilot control input.	✓				
12.e.10	The visual system should provide appropriate height and 3-D object collision detection feedback, based on helicopter geometry, to support training.	✓	✓	✓	✓	✓
12.f	Scene quality.					
12.f.1	Quantization.					
12.f.1.a	Surfaces and textural cues should be free from apparent quantization (aliasing).			✓	✓	✓
12.f.1.b	Surfaces and textural cues should not create distracting quantization (aliasing).	✓	✓			
12.f.2	System capable of portraying full colour realistic textural cues.		✓	✓	✓	✓
12.f.3	The system light-points should be free from distracting jitter, smearing or streaking.	✓	✓	✓	✓	✓
12.f.4	System capable of providing focus effects that simulate rain.		✓	✓	✓	✓
12.f.5	System capable of providing light-point perspective growth.		✓	✓	✓	✓
12.f.6	Demonstration of occulting through each channel of the system in an operational scene.	✓	✓	✓	✓	✓
12.g	Environmental effects.					
12.g.1	The displayed scene should correspond to the appropriate surface contaminants and include runway lighting reflections for wet, partially obscured lights for snow, or suitable alternative effects.		✓	✓	✓	✓
12.g.2	Special weather representations, which include the sound, motion and visual effects of light, medium and heavy precipitation near a thunderstorm on take-off, approach and landings at and below an altitude of 600 m (2 000 ft) above the airport or landing area surface and within a radius of 16 km (10 sm) from the aerodrome.		✓	✓	✓	✓
12.g.3	One airport or landing area with a snow scene, if appropriate to the operator’s area of operations, to include terrain snow and snow-covered surfaces.		✓	✓	✓	✓
12.g.4	In-cloud effects such as variable cloud density, speed cues and ambient changes should be provided.		✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
12.g.5	The effect of multiple cloud layers representing few, scattered, broken and overcast conditions giving partial or complete obstruction of the ground scene.		✓	✓	✓	✓
12.g.6	The effect of a cloud layer with adjustable base and top giving complete obstruction of the ground scene.	✓				
12.g.7	Gradual breakout to ambient visibility/RVR, defined as up to 10% of the respective cloud base or top, 6.1 m (20 ft) ≤ transition layer ≤ 61 m (200 ft); cloud effects should be checked at and below a height of 600 m (2 000 ft) above the aerodrome or helicopter landing area and within a radius of 16 km (10 sm) from the aerodrome or helicopter landing area. Transition effects should be complete when the IOS cloud base or top is reached when exiting and start when entering the cloud, i.e. transition effects should occur within the IOS defined cloud layer.		✓	✓	✓	✓
12.g.8	Visibility and RVR measured in terms of distance. Visibility/RVR should be checked at and below a height of 600 m (2 000 ft) above the aerodrome or helicopter landing area and within a radius of 16 km (10 sm) from the aerodrome or helicopter landing area.	✓	✓	✓	✓	✓
12.g.9	Patchy fog (sometimes referred to as patchy RVR) giving the effect of variable RVR. The lowest RVR should be that selected on the IOS, i.e. variability is only > IOS RVR.			✓	✓	✓
12.g.10	Effects of fog on aerodrome or helicopter landing area lighting such as halos and defocus.		✓	✓	✓	✓
12.g.11	Effect of ownship lighting in reduced visibility, such as reflected glare, to include landing lights, search lights, strobes, and beacons.		✓	✓	✓	✓
12.g.12	Wind cues to provide the effect of blowing snow or sand across a dry runway or taxiway or landing area surface should be selectable from the instructor station.			✓	✓	✓
12.g.13	The effect of ownship downwash upon the surface (e.g. grass, dirt, water).		✓	✓	✓	✓
12.g.14	“Whiteout” or “brownout” recirculation effects of own helicopter’s rotor downwash upon various surfaces such as snow, sand, dirt, water and grass including the effects of reduced visibility beginning at a distance above the ground equal to approximately one half the rotor diameter.		✓	✓	✓	✓
12.g.15	The effects of swell and wind on a 3-dimensional ocean model should be simulated including wind lanes; sea states of 0 to 6 should be provided. Ships and other moving vessels in the ocean should conform to the sea state.		✓	✓	✓	✓
12.g.16	The effect of trees movement in confined areas.			✓	✓	✓
12.g.17	Precipitation effects for rain, hail and snow.		✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
13	**Motion and vibration effects.** The following specific motion and vibration effects are required to indicate the threshold at which a flight crew member should recognize an event or situation. Where applicable below, the FSTD pitch, side loading and directional control characteristics, as well as the vibrations characteristics, should be representative of the helicopter.					
13.a	Taxiing effects such as lateral, directional and longitudinal cues resulting from steering and braking inputs.				✓	✓
13.b	Effects of runway rumble, oleo deflections, ground speed, uneven runway, runway centre line lights, runway contamination and taxiway characteristics. Procedure: after the helicopter has been preset to the take-off position and then released, taxi at various speeds with a smooth runway and note the general characteristics of the simulated runway rumble effects. Repeat the manoeuvre with a runway roughness of 50% and with maximum roughness. Note the associated motion vibrations affected by ground speed and runway roughness. Similar tests are conducted on taxiways at various taxi speeds. The associated motion effects for the above tests should also include an assessment of the effects of rolling over centre line lights, of surface discontinuities of uneven runways, and of various taxiway characteristics. If time permits, different gross weights can also be selected as this may also affect the associated vibrations depending on the helicopter type.				✓	✓
13.c	Friction drag from skid-type landing gear. Procedure: perform a running take-off or a running landing and note a change (increase or decrease) with speed in fuselage vibrations (as opposed to rotor vibrations) due to the friction of dragging the skid along the surface. This vibration will lessen as the ground speed decreases.	✓	✓	✓	✓	✓
13.d	Translational lift effect (including transverse flow effect). Procedure: from a stabilized in-ground-effect (IGE) hover, begin a forward acceleration. When passing through the effective translational lift range, the noticeable effect will be a possible nose pitch-up in some helicopters, an increase in the rate of climb, and a temporary increase in vibration level (in some cases this vibration may be pronounced). This effect is experienced again upon deceleration through the appropriate speed range. During deceleration, the pitch and rate of climb will have the reverse effect, but there will be a similar, temporary increase in vibration level.	✓	✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
13.e	Bumps/buffets associated with landing gear. Procedure: perform a normal take-off paying special attention to the bumps that could be perceptible due to maximum oleo extension after lift-off. When the landing gear is extended or retracted, motion bumps may be felt when the gear locks into position. Operate the landing gear. Check that the motion cues of the buffet experienced represent the actual helicopter.				✓	✓
13.f	Rotor out-of-track and/or out-of-balance condition including icing conditions. Procedure: select the malfunction or condition from the IOS. Start the engine(s) normally and check for an abnormal vibration for an out-of-track condition and check for an abnormal vibration for an out-of-balance condition. This test does not require becoming airborne. The abnormal vibration for out-of-track and out-of-balance conditions should be recognized in the frequency range of the inverse of the period P of rotation of the main rotor for each condition, i.e. 1/P for vertical vibration caused by an out-of-track condition, and 1/P for lateral vibration caused by an out-of-balance condition.	✓	✓	✓	✓	✓
13.g	Failure of dynamic vibration absorber or similar system as appropriate for the helicopter (e.g. droop stop or static stop). Procedure: the test may be accomplished any time the rotor is engaged. Select the appropriate failure at the IOS, note an appropriate increase in vibration and check that the vibration intensity and frequency increase with an increase in RPM and the vibration intensity increases with an increase in collective application.			✓	✓	✓
13.h	Tail rotor drive malfunction/vibrations. Procedure: with the engine(s) running and the rotor engaged, select the malfunction and note the immediate increase of medium frequency vibration. The tail rotor operates in the medium frequency range, normally estimated by multiplying the tail rotor gear box ratio by the main rotor RPM. The failure can be recognized by an increase in the vibrations in this frequency range. Vibrations may be transmitted via the pedals as well.	✓	✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
13.i	Representative cues resulting from touchdown. Procedure: conduct several touchdowns with various rates of descent, from a hover and run-on. Check that the motion cues for the touchdown bumps for each descent rate and speed are representative of the actual helicopter.				✓	✓
13.j	Tire failures. Procedure: simulate tire failures and note effects of yaw, motion, vibration and sound effects. The pilot may notice some yawing with a failure of multiple tires selected on the same side. This should require the use of the pedal to maintain control of the helicopter. Dependent on the helicopter type, a single tire failure may not be noticed by the pilot and may not cause any special motion effect. Sound or vibration may be associated with the actual tire losing pressure.				✓	✓
13.k	Engine malfunction and engine damage effects. Procedure: the characteristics of an engine malfunction as prescribed in the malfunction definition document for the particular FSTD must describe the special motion effects felt by the pilot. Note the associated engine instruments varying according to the nature of the malfunction and note the replication of the effects of the airframe vibrations. *Note.— Motion effects apply to Type IV and V devices.*	✓	✓	✓	✓	✓
13.l	Tail strikes. Procedure: tail-strikes can be checked by over-rotation of the helicopter at a quick stop or during autorotation to the ground. It can also be checked in the hover by a rapid aft cyclic input. The motion effect should be felt initially by a motion bump as the tail guard hits the surface. A nose down pitching moment may possibly be noticeable after the strike.				✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
13.m	Vortex ring state (settling with power). Procedure: specific procedures may differ between helicopters and may be prescribed by the helicopter manufacturer or other subject matter expert. However, the following information is provided for illustrative purposes. To enter the manoeuvre, reduce power below hover power descending vertically or near vertically, allowing sink rate to increase to 1.5 m/s (300 ft/min) or more (actual sink rate value will depend on the helicopter type simulated). Adjust attitude to obtain airspeeds of less than 10 knots. The aircraft will shudder entering the vortex ring state. During the initial stage (when a large amount of excess power is available), a large application of collective pitch may arrest rapid descent. If done carelessly or too late, collective increase can aggravate the situation resulting in more turbulence and an increased rate of descent and an increase in vibrations level. In single-rotor helicopters, the recovery can be accomplished by applying cyclic to gain airspeed and arrest the upward induced flow of air and/or by lowering the collective (altitude permitting). Normally, gaining airspeed is the preferred method as less altitude is lost. In tandem-rotor helicopters, fore and aft cyclic inputs aggravate the situation. By lowering thrust (altitude permitting) and applying lateral cyclic input or pedal input to arrest the upward induced flow of air, the pilot can accomplish recovery.			✓	✓	✓
13.n	Retreating blade stall. Procedure: specific procedures may differ between helicopters and may be prescribed by the helicopter manufacturer or other subject matter expert. However, the following information is provided for illustrative purposes: to enter the manoeuvre, increase forward airspeed; the effect will be recognized through the development of a low frequency vibration, pitching up of the nose, and a roll in the direction of the retreating blade. High weight, low rotor RPM, high density altitude, turbulence or steep, abrupt turns are all conducive to retreating blade stall at high forward airspeeds. Correct recovery from retreating blade stall requires the collective to be lowered first, which reduces the disk loading. Aft cyclic can then be used to slow the helicopter.				✓	✓
13.o	High speed vibrations.			✓	✓	✓
13.p	Buffet due to atmospheric disturbances.				✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
13.q	Other.					
14	**Sound system.** *Note.— Checks should be performed with the motion and vibration systems ON.*					
14.a	Precipitation.			✓	✓	✓
14.b	Rain removal equipment (e.g. wipers).			✓	✓	✓
14.c	Significant helicopter noises perceptible to the pilot during normal operations, such as noises from engine, transmissions, rotors or other sources, to a level comparable to that found in the helicopter. Representative sound directionality.			✓	✓	✓
14.d	Significant helicopter cockpit sounds and those which result from an action by the pilot.	✓	✓	✓	✓	✓
14.e	Abnormal operations for which there are associated sound cues including, but not limited to, engine, rotors, transmissions malfunctions, landing gear/tire malfunctions and tail guard/stinger/hockey stick strike.	✓	✓	✓	✓	✓
14.f	Sound of a crash when the helicopter is landed in excess of limitations or in unusual attitudes.	✓	✓	✓	✓	✓
15	**Special effects.**					
15.a	Effects of airframe, engine and rotor icing. Procedure: with the FSTD airborne, in a clean configuration, nominal altitude and cruise airspeed, autopilot ON, engine and airfoil anti-ice/de-ice systems deactivated, activate icing conditions at a rate that allows monitoring of FSTD and systems response. Icing recognition will include an increase in gross weight, increase in power required to maintain level flight, airspeed decay, change in FSTD pitch attitude, change in engine performance indications (other than due to airspeed changes), and change in data from pitot/static system, or symptoms of rotor out-of-track or out-of-balance. Activate heating, anti-ice, or de-ice systems independently. Recognition will include proper effects of these systems, eventually returning the simulated helicopter to normal flight.				✓	✓
15.b	Airflow patterns and respective effects associated with large structures, such as buildings and oil rigs, confined areas, mountain peaks including demarcation lines, etc.			✓	✓	✓
15.c	Special atmospheric effects, as may be required for a specific training programme, such as arctic sea smoke, katabatic winds, mountain effects (rotors, demarcation lines, etc.), oil rig exhaust turbulence, wake vortices and downwash effects from other aircraft.			✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
16	**Air traffic control (ATC) system.** *Note.— All functions below can be performed directly by the instructor or be programmed from the IOS using features of an ATC environment simulation system.*					
16.a	Automated weather reporting.	✓	✓	✓	✓	✓
16.b	Party-line (background chatter).					✓
16.c	Phraseology.					✓
16.d	Flight phase specific ATC frequency recognition.					✓
16.e	Instructor override of the system.	✓	✓	✓	✓	✓
16.f	Other.					
17	**Instructor operating station.**					
17.a	Repositions. *Note.— Repositions should end in-trim at the appropriate speed and configuration for the point.*					
17.a.1	Parking spot.	✓	✓	✓	✓	✓
17.a.2	Take-off position.	✓	✓	✓	✓	✓
17.a.3	Approach position (at least at three distances of 1.8, 5.5, 9.3 km (1, 3, 5 nm) from the runway threshold or helicopter landing area).	✓	✓	✓	✓	✓
17.a.4	Elevated surface position (building top, offshore oil rig, etc.).			✓	✓	✓
17.a.5	Confined landing area.			✓	✓	✓
17.a.6	On a slope.			✓	✓	✓
17.a.7	Other.					
17.b	Resets.					
17.b.1	System.	✓	✓	✓	✓	✓
17.b.2	Temperature.	✓	✓	✓	✓	✓
17.b.3	Fluids and agents.	✓	✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
17.c	Environment.					
17.c.1	Weather presets.					
17.c.1.a	CAVU (ceiling and visibility unlimited).	✓	✓	✓	✓	✓
17.c.1.b	CAVOK. (ceiling and visibility Ok).	✓	✓	✓	✓	✓
17.c.1.c	VFR.	✓	✓	✓	✓	✓
17.c.1.d	Non-precision approach minimums.	✓	✓	✓	✓	✓
17.c.1.e	Precision approach minimums (CAT I, CAT II, EFVS minimums, as appropriate).	✓	✓	✓	✓	✓
17.c.2	Visual effects.					
17.c.2.a	Time of day (day, dusk or dawn, night).	✓	✓	✓	✓	✓
17.c.2.b	Clouds (bases, tops, layers, types, density).	✓	✓	✓	✓	✓
17.c.2.c	Visibility in kilometres/statute miles.	✓	✓	✓	✓	✓
17.c.2.d	RVR in metres/feet.	✓	✓	✓	✓	✓
17.c.2.e	Special effects (precipitation; thunderstorms; blowing snow, blowing sand, etc.).		✓	✓	✓	✓
17.c.2.f	Sand/dust/snow/water downwash/recirculation effect ON/OFF.		✓	✓	✓	✓
17.c.2.g	Sea state conditions (0-6).		✓	✓	✓	✓
17.d	Wind speed and direction.					
17.d.1	Surface.	✓	✓	✓	✓	✓
17.d.2	Intermediate levels.		✓	✓	✓	✓
17.d.3	Typical gradient.			✓	✓	✓
17.d.4	Gusts with associated heading and speed variance.	✓	✓	✓	✓	✓
17.d.5	Turbulence.	✓	✓	✓	✓	✓
17.e	Temperature — surface.	✓	✓	✓	✓	✓
17.f	Atmospheric pressure (QNH, QFE).	✓	✓	✓	✓	✓
17.g	Airport/heliport.					

Number	Functions and Subjective Tests	Type				
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17.g.1	To include active runway or landing area selection.	✓	✓	✓	✓	✓
17.g.2	Airport/heliport lighting controls.	✓	✓	✓	✓	✓
17.g.3	Airport/heliport preset positions (take-off, approach, oil rig, etc.).	✓	✓	✓	✓	✓
17.g.4	Landing surface conditions (rough, smooth, icy, wet, etc.).		✓	✓	✓	✓
17.g.5	Dynamic effects including ground and airborne traffic.		✓	✓	✓	✓
17.h	Helicopter configuration (fuel, weight, CG, etc., in imperial and metric units).					
17.h.1	Gross weight.	✓	✓	✓	✓	✓
17.h.2	Fuel loading.	✓	✓	✓	✓	✓
17.h.3	Payload.	✓	✓	✓	✓	✓
17.h.4	CG (in units appropriate to the helicopter type, e.g. inches, mm).	✓	✓	✓	✓	✓
17.h.5	Helicopter systems status/control (e.g. rapid navigation system (NAV) alignment (IRS, GPS, AHRS), others).	✓	✓	✓	✓	✓
17.h.6	Ground crew functions (ground power, etc.).	✓	✓	✓	✓	✓
17.i	FMS — reloading of programmed data unless precluded by installed equipment.			✓	✓	✓
17.j	Plotting and recording (take-off and approach).	✓	✓	✓	✓	✓
17.k	Helicopter malfunctions (inserting and removing).	✓	✓	✓	✓	✓
17.l	Sound controls (ON, OFF and adjustment; indication of when the sound level is set to a value other than the approved level).	✓	✓	✓	✓	✓
17.m	Motion system (ON, OFF and emergency stop).				✓	✓
17.n	Control loading system (ON, OFF and emergency stop).	✓	✓	✓	✓	✓
17.o	Vibration system (ON, OFF and emergency stop).	✓	✓	✓	✓	✓
17.p	Simulator master/emergency power switch “OFF”.	✓	✓	✓	✓	✓
17.q	Observer seats position/adjustment system and positive restraint system (for FSTD with motion).				✓	✓
17.r	Communication between the instructor/observer(s) and the flight crew.	✓	✓	✓	✓	✓

Number	Functions and Subjective Tests	Type				
		I	II	III	IV	V
17.s	Freezes/resets.					
17.s.1	Complete simulation freeze.	✓	✓	✓	✓	✓
17.s.2	Flight/problem freeze.	✓	✓	✓	✓	✓
17.s.3	Position freeze.	✓	✓	✓	✓	✓
17.s.4	Fuel freeze.	✓	✓	✓	✓	✓
17.s.5	Ground speed control.	✓	✓	✓	✓	✓
17.s.6	Standard atmosphere reset.	✓	✓	✓	✓	✓

Appendix D

Future Doc 9625 (MCQFSTD) Updates

1. INTRODUCTION

Simulation technology and training research will continue to advance. It is likely that at some stage, before later revisions of this document are published, other technical standards or solutions to meet the criteria specified herein may be proposed. This appendix details the process to be undertaken prior to an update to the *Manual of Criteria for the Qualification of Flight Simulation Training Devices* (MCQFSTD) being considered.

2. PROCESS

2.1 Prior to considering an inclusion of alternate standards or solutions, the related proposal must include, as a minimum, the items listed in 2.2 to 2.6 below to the satisfaction of the NAA(s) concerned.

2.2 A detailed description of the technical proposal including differences and advantages in comparison with existing means of compliance for the criteria or requirement in question.

2.3 Demonstration by the applicant to the satisfaction of the NAA that the alternate standard or solution achieves a level of training capability at least equivalent to that provided by existing means. This should include evidence that existing training and training-to-proficiency outcomes have been achieved.

2.4 Revised or additional validation testing criteria to be used in FSTD evaluation and qualification.

2.5 Revised or additional functional and subjective testing criteria to be used in FSTD evaluation and qualification.

2.6 Publication of supporting regulatory guidance documentation, based on the technical proposal, the demonstration by the applicant and the revised or additional criteria described above.

2.7 When the items listed in 2.2 to 2.6 are submitted to the International Committee for FSTD Qualification (ICFQ), the ICFQ, after establishing that the international training community supports the alternate standards or solutions, prepares an update to Doc 9625.

3. FLOW CHART

Figure D-1 illustrates the process to be followed for an update to the Doc 9625 (MCQFSTD) to be considered.

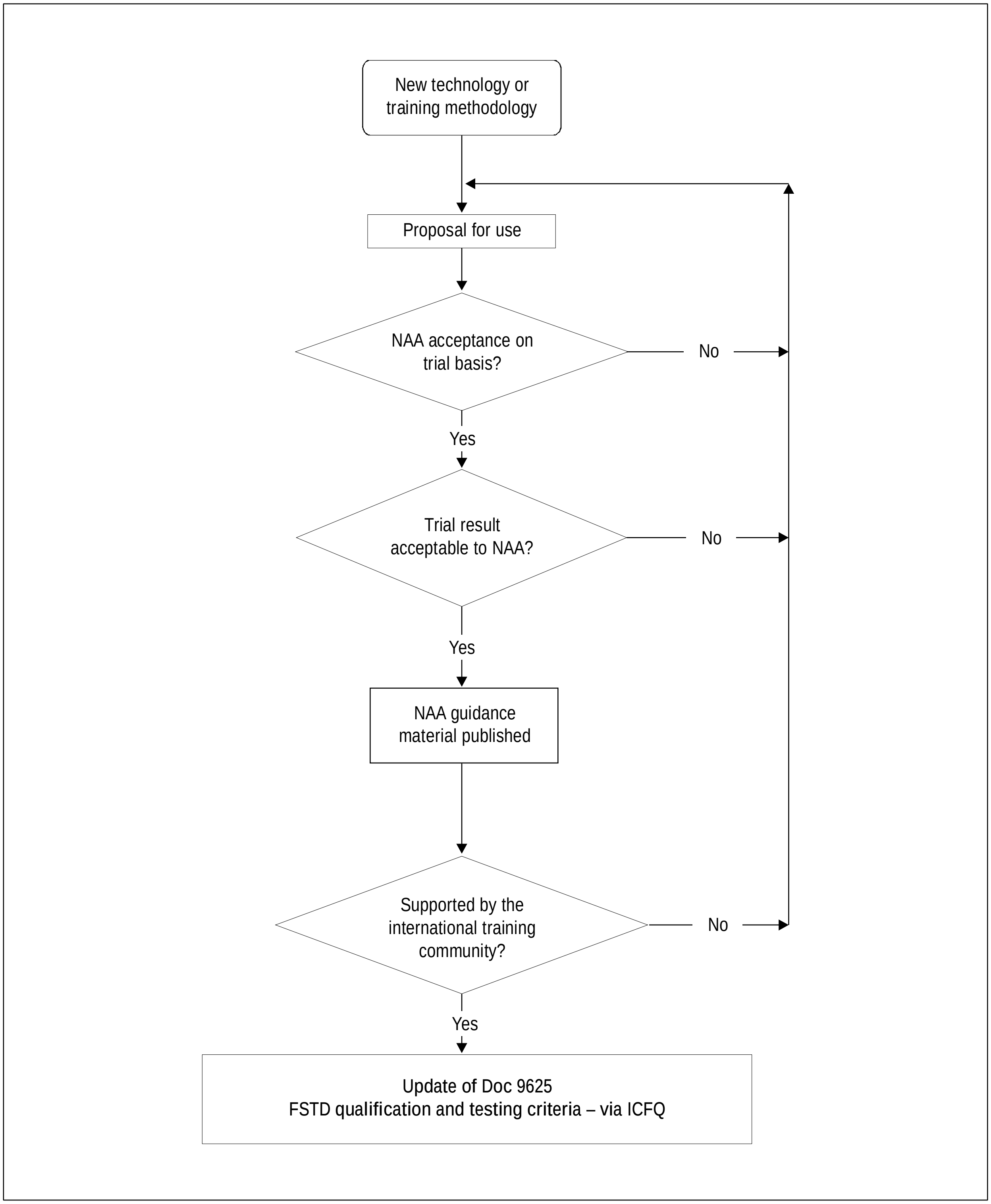

Figure D-1. Doc 9625 (MCQFSTD) Update Process

Attachment A

FSTD QUALIFICATION FOR NEW HELICOPTER TYPES

1.1 Helicopter manufacturers' final approved data for performance, handling qualities, systems or avionics are usually not available until after a new or derivative helicopter has entered service. In order to minimize the associated risk, every effort should be made to provide the final data as soon as possible. However, it may be necessary to use helicopter manufacturer-provided preliminary data for interim qualification of flight simulation training devices (FSTDs), so that flight crew training can begin prior to the entry of the first helicopter into service. The amount of flight crew training credit should be evaluated by the NAA, which may choose to impose a time limit or other limitations until final FSTD qualification has been granted.

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

1.3 FSTD qualification should be based upon approved data. Operators seeking qualification based on preliminary data should, however, consult the NAA 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 FSTD qualification. Helicopter and FSTD manufacturers should also be made aware of the needs and be agreed parties to the data plan and FSTD qualification plan. The plans should include periodic meetings to keep the interested parties informed of project status.

1.4 The precise procedure followed to gain NAA 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 FSTD operator, the helicopter manufacturer, the FSTD manufacturer and the NAA.

Note.— A description of helicopter manufacturer-provided data needed for FSTD modelling and validation is to be found in the RAeS document Data Package Requirements for Design and Performance Evaluation of Rotary Wing Synthetic Training Devices*, First Release, April 2004 or as amended.*

1.5 There should be assurance that the preliminary data are the manufacturer's best representation of the helicopter in its current state (prototype or pre-serial helicopter). This configuration current state should be advanced enough to be judged representative of the future serial helicopter and therefore acceptable to train pilots. If a baseline configuration certification is foreseen for the helicopter soon enough before final certification, this configuration should be used as reference for interim qualification. Data derived from these predictive or preliminary techniques should be validated by available sources including, at least, the following:

a) Manufacturer's engineering report. Such a report should explain the predictive method used and illustrate 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. This demonstration should be done to a closest helicopter (e.g. same family or similar dimensions and rotors technology).

b) Early flight test results. Such data will often be derived from helicopter certification tests and should be used to maximum advantage for early FSTD qualification. Certain critical tests, which would normally be done early in the helicopter certification programme, should be included to validate the helicopter simulation model(s) to support essential pilot training. These include cases in which a pilot is expected to cope with engine and drive train failures and autorotation to touchdown. The early data available, however, will depend on the helicopter manufacturer's flight test programme design and may not be the same in each case. However, it is expected that the helicopter manufacturer's flight test programme would include provisions for generation of very early flight test results for FSTD qualification.

1.6 The preliminary data supporting an interim qualification are not intended to be used for an indefinite period. The helicopter manufacturer's final data should be made available as soon as practicable (typically within six months) after the helicopter's first "service entry" or as agreed by the NAA, the FSTD operator and the helicopter manufacturer. In applying for an interim qualification, using preliminary data, the FSTD operator and the NAA should agree upon the update programme. This will normally specify that the final data update will be installed in the FSTD within a period of six months following the final data release.

1.7 Hardware and software FSTD configuration should remain aligned with that of the helicopter, as far as possible. The time lapse between helicopter and FSTD updates should be minimized; this may depend on the magnitude of the update and whether the QTG and pilot training and checking are affected. Permitted differences in helicopter and FSTD configurations and the resulting effects on FSTD qualification should be agreed between the operator and the NAA. Consultation with the FSTD manufacturer is desirable throughout the agreement of the qualification process.

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

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

1.8.2 In order to ensure that the two sets of data are properly validated, the helicopter manufacturer should compare its simulation model responses against the flight-test data. The simulation should be validated in an integrated fashion, be consistent with the design data released to the FSTD manufacturer, and should at least include the following elements:

a) engine state;

b) aerodynamics;

c) mass properties;

d) flight controls;

e) stability augmentation; and

f) brakes/landing gear.

Note.— The POM should meet the relevant tolerances.

1.9 For the qualification of FSTDs of new helicopter types, it may be beneficial that the services of a suitably qualified NAA or helicopter manufacturer's test pilot be used for the purpose of assessing handling qualities and performance evaluation.

Attachment B

ENGINEERING SIMULATION VALIDATION DATA

1. BACKGROUND

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

1.2 Traditionally as the helicopter configuration has been revised, the simulation models have consequently been revised to reflect changes. In the case of aerodynamic, engine, flight control and ground handling models, this revision process normally results in the collection of additional flight test data and the subsequent release of updated models and validation data.

1.3 The quality of the prediction of simulation models may advance to the point where differences between predicted and flight-test-validated models could be quite small.

1.4 Helicopter manufacturers may use the same simulation models in engineering simulators as those used by the training community. These simulation models may be derived from a variety of physical engineering simulators, ranging from those which incorporate helicopter hardware through to non-real-time workstation-based simulations.

2. APPROVAL GUIDELINES FOR USING ENGINEERING SIMULATION VALIDATION DATA

2.1 The current practice of requiring flight test data as a reference for validating training simulators is the preferred approach and should continue.

2.2 When these data are unavailable or unusable or a flight-test-validated simulation is modified as a result of changes to the simulated helicopter configuration, a helicopter manufacturer or other approved data supplier may choose, with prior agreement of the NAA(s), to supply validation data from an engineering simulator to selectively supplement flight test data.

2.3 In cases where data from an engineering simulator are used, the engineering simulation process should be audited by the appropriate NAA(s).

2.4 In all cases involving a new helicopter type, a data package of the “entry-into-service” configuration of the baseline helicopter, verified to current standards against flight tests, should be developed.

2.5 Where engineering simulator data are used as part of a QTG, a match is expected as described in Attachment C to this Part.

2.6 In cases where the use of engineering simulator data is envisaged, a complete proposal should be presented to the appropriate NAA(s). Such a proposal would contain evidence of the engineering simulator data supplier’s past achievements in high-fidelity modelling. The NAA(s) should conduct technical reviews of the proposed plan and of the subsequent validation data to establish acceptability of the proposal.

2.7 The flight-validated data may be modified once to produce derived data, but the derived data may not be processed further. In the event that subsequent changes are necessary, the original flight-test-validated data must be used to produce a new set of derived data.

2.8 A configuration management process should be maintained, including an audit trail which clearly defines the simulation model changes in detail, so that it would be possible to return to the baseline (flight-validated) version.

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

2.10 To be admissible as an alternative source of approved flight data for use in a training simulator, an engineering simulator should:

a) exist as a physical entity, complete with a cockpit, with controls sufficient for manual flight;

b) have a visual system and preferably also a motion system;

c) where appropriate, have actual avionics boxes interchangeable with the equivalent software simulations, to support validation of released software;

d) have a rigorous configuration control system covering hardware and software; and

e) have been found to be a high-fidelity representation of the helicopter by the pilots of the manufacturers, operators and the NAA(s).

2.11 Engineering simulators used to produce system data may not need all the above features.

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

a) the original (baseline) simulation models should have been flight-test-validated;

b) the models as released by the helicopter manufacturer to the industry for use in FSTDs used in training should be essentially identical to those used by the helicopter manufacturer in its engineering simulations/simulators; and

c) these engineering simulations/simulators will have been used as part of the helicopter design, development or modification process.

2.13 FSTDs used in training and utilizing these baseline simulation models should be currently qualified to at least internationally recognized standards such as those contained in this manual.

2.14 The types of modification covered by this alternative procedure will be restricted to those with “well-understood effects”, such as:

a) software (e.g. flight control computer, autopilot);

b) revisions with predictable aerodynamic impact;

c) engines; and

d) control system gearing/rigging/deflection limits.

2.15 The FSTD operator who wishes to take advantage of this alternative procedure is expected to demonstrate a sound engineering basis for its proposed approach. Such analysis would show that the predicted effects of the change(s) were incremental in nature, and both easily understood and well defined, confirming that additional flight test data were not required. In the event that the predicted effects were not deemed to be sufficiently accurate, it might be necessary to collect a limited set of flight test data to validate the predicted increments.

2.16 The NAA(s) should review any applications for this procedure and provide feedback.

Attachment C

VALIDATION TEST TOLERANCES

1. BACKGROUND

1.1 The tolerances listed in Appendix B to this Part are designed to be a measure of quality of match using flight test data as a reference.

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

a) flight test data are subject to many sources of potential error, e.g. instrumentation errors and atmospheric disturbance during data collection;

b) data that exhibit rapid variation or noise may also be difficult to match; and

c) engineering simulator data and other calculated data may exhibit errors due to a variety of potential differences listed in 1.5 of this attachment.

1.3 When applying tolerances to any test, good engineering judgment with reference to section 1.5 of this attachment should be applied. Where a test clearly falls outside the prescribed tolerance(s) for no acceptable reason, it should be judged to have failed.

1.4 The use of engineering validation data as reference data has historically been quite small for helicopter FSTD validation. The inclusion of this type of data as a validation source is expanding, in particular due to the introduction of more engineering simulation during the design process of modern helicopters and the need for alternate data for design and validation of FSTDs representing older helicopter types for which flight test data are not available. When engineering validation data are used, it is understood that the flight test-based tolerances should be reduced since applied tolerances should not include measurement errors inherent to flight test data.

1.5 There are reasons why the results from an FSTD would differ from engineering validation test data. These reasons include, but are not limited to:

a) hardware (avionics and flight controls);

b) modelling solutions used in the FSTD are different from those used by the aircraft original equipment manufacturer (ground handling models, braking models, engine models, etc.);

c) model cascading effects:

1) iteration rates;

2) execution order;

3) integration methods; and

4) processor architecture;

d) digital drift:

1) interpolation methods;

2) data handling differences; and

3) auto-test trim tolerances, etc.;

e) open loop versus closed loop responses, and test duration;

f) extent of dependency on contributory aircraft systems adding to the complexity of the test; and

g) accuracy of the match of the initial conditions.

1.6 Any differences between FSTD results and engineering validation data should, however, be small and the reasons for any differences, other than those listed in 1.5 of this attachment, should be clearly explained.

1.7 Historically, engineering validation data were used only to demonstrate compliance with certain extra modelling features because:

a) flight test data could not reasonably be made available;

b) data from engineering simulations made up only a small portion of the overall validation data set; and

c) key areas were validated against flight test data.

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

a) flight test data are often not available due to valid technical reasons; and

b) alternative technical solutions are being advanced.

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

2. TEST TOLERANCES WITH ENGINEERING VALIDATION DATA

2.1 Where engineering validation data are used as an allowable form of reference validation data for the objective tests listed in Appendix B, the match obtained between the reference data and the FSTD results should be very close. It is not possible to define a precise set of tolerances, as the reasons for reaching other than an exact match will vary depending upon a number of factors discussed in Section 1.

2.2 When engineering validation data are used for reference data, the tolerance applied should be 40 per cent of the corresponding "flight test" tolerances, and out-of-tolerance flagging should be in accordance with this guideline. For this 40 per cent tolerance to be applicable, the data provider should supply a well-documented mathematical model and testing procedure that enables an exact replication of its engineering simulation results.

2.3 If the difference between the reference data and the FSTD results exceeds 40 per cent of the "flight test" tolerances, the FSTD manufacturer should provide a clear rationale for each affected QTG test case.

2.4 The validation data suppliers (e.g. aircraft manufacturers) may identify cases where the suggested 40 per cent tolerance cannot be met. In such cases the data suppliers should provide a rationale as part of their validation data roadmap.

2.5 Where the engineering simulation used to generate reference data includes aircraft hardware, the tolerances applied may have to be increased above the suggested 40 per cent. A rationale should be provided.

2.6 FSTD results should be obtained without having to change the simulation models of the FSTD to meet the criteria for exact replication of the engineering simulation results.

Attachment D

VALIDATION DATA ROADMAP

1.1 Helicopter manufacturers or other sources of data should supply a validation data roadmap (VDR) document as part of the data package. A VDR document contains guidance material from the helicopter validation data supplier recommending the best possible sources of data to be used as validation data in the QTG. A VDR should be submitted to the NAA as early as possible in the planning stages for any flight simulation training device planned for qualification to the standards contained herein. The respective NAA is the final authority to approve the data to be used as validation material for the QTG.

1.2 The VDR should clearly identify (in matrix format) sources of data for all required tests. It should also provide guidance regarding the validity of these data sources according to the helicopter configuration used as reference for FSTD qualification. This reference configuration should be described at the required level with presentation of all items which may have an impact on performance and handling qualities. This reference configuration should describe as a minimum: external aerodynamic configuration of the helicopter including rotors; engine type; engine control unit version; and AFCS version. For each of these, a comparison should be done between the configurations used to generate validation data and the reference configuration, with justification that the non-reference configurations used are acceptable because they do not have a significant impact on performance and handling qualities of the reference configuration. The document should include rationale or explanation in cases where:

– data or parameters are missing or partially available;

– engineering simulation data are to be used;

– flight test methods or measurement principles require explanation; and

– any deviation exists from data requirements, with a brief narrative describing their cause and effect.

1.3 The VDR or other dedicated validation data roadmap document(s) should provide the same information on other types of validation data required for qualification such as control forces, sound or vibrations. It is recommended that the VDR be broken down into 3 parts:

– Part 1 providing a matrix (see paragraph 1.4) which allows to clearly identify the complete list of tests foreseen for qualification and, for each test, the source of validation data;

– Part 2 providing guidance regarding the validity of the validation data in accordance with the reference configuration; and

– Part 3 providing rationales with the objective to describe the cause and effect of deviations from data requirements in order to justify that the reference data are acceptable for qualification.

1.4 Table D-1 depicts an example of a roadmap matrix identifying sources of validation data. Only a subset of the full matrix is shown; some test conditions were deleted for brevity. Relevant regulatory material should be consulted and all applicable tests addressed in the actual VDR document submitted. Validation sources, validation data documents, and comments provided herein are for reference only. The actual data sources and documents will be dependent upon the particular airframe/engine combination under consideration. The following set of guidelines should be used when applying this example to a specific VDR document.

1.4.1 Include column "Tests reference number" to provide a reference identification for each test required for qualification.

1.4.2 Include columns “Test description,” “Conditions,” “Weight” and “Flight control mode” (the actual column names may be adapted to the particular case) to describe test conditions including at minimum: test title (as defined in this document), summarized test conditions (allowing identification of each test condition required by the qualification criterion), weight condition (low, high, undetermined) and AFCS condition (e.g. normal/degraded).

1.4.3 Include a column “Validation source” to define the source of validation data: codes (explicitly described in the VDR) used to allow identification of the type of data (flight tests, engineering data, etc.) and platform used (helicopter reference, etc.).

1.4.4 Include a column “Validation document” to allow for a link to references used in the POM and QTG.

1.4.5 Include a column “Comment” to be used for additional explanations with or without links to rationales provided in the VDR.

1.5 Table D-1 is an example only, and other formats may be acceptable to the NAA(s).

1.6 Additionally, two examples of “rationale pages” are presented in Tables D-2 and D-3. These illustrate the type of helicopter and avionics configuration information and descriptive engineering rationale used to describe data anomalies, provide alternative data, or provide an acceptable basis to the NAA for obtaining deviations from QTG validation requirements.

Table D-1. Validation of Data Roadmap (example matrix identifying sources of validation data)

Tests Ref. #	Test description	Conditions	Weight	Flight Control Mode	Validation source	Validation document POM reference	Comment
1.a.(1).(i)	ENGINE START AND ACCELERATION	on ground, with rotor brake disengaged engine 1	U	ATT	FT 1	1a11.1n1a	See VDR Rationale 003 for engine parameters validity
1.a.(1).(i)	ENGINE START AND ACCELERATION	on ground, with rotor brake disengaged engine 2	U	ATT	FT 1	1a11.1n1b	
1.a.(1).(i)	ENGINE START AND ACCELERATION	on ground with rotor brake engaged	U	ATT	FT 1	1a11.1n2	
1.a.(1).(ii)	STEADY STATE IDLE	on ground both engines on idle	U	ATT	FT 2	1a12.1n1_t	Snapshot test
1.a.(1).(ii)	OPERATING RPM	on ground both engines on flight	U	ATT	FT 2	1a12.1n2_t	
1.a.(2)	POWER TURBINE SPEED TRIM	on ground, both engines on flight engine response to 1st trim direction					Not applicable for this type of Helicopter See VDR Rationale 004
1.c.(2)	TAKE-OFF	OEI continued take-off	U	ATT	FT 2	1c2.1n	Usage of OEI training mode for safety reasons
1.c.(3)	TAKE-OFF	OEI rejected take-off	U	ATT	FT 2	1c3.1n	
1.f	LEVEL FLIGHT PERFORMANCE	V_y	L	SAS	FT 2	1f.5d1_t1	Snapshot test
1.g	CLIMB PERFORMANCE	V_y all engines operating	L	SAS	FT 2	1g.4d1_1	
1.h.(1)	DESCENT PERFORMANCE	V_y	L	SAS	FT 2	1h1.6d1	
1.h.(2)	AUTOROTATION	~50kt	L	SAS	FT 2	1h2.8d1_t1	Snapshot test
2.b.(1)	LOW AIRSPEED TRIMMED FLIGHT CONTROL POSITIONS	left sideward flight intermediate airspeed	U	ATT	FT 2	2b1.2nl_t1	Snapshot test See VDR Rationale 007 for translational airspeed limits in rearward and sideward flight
2.b.(2)	CRITICAL AZIMUTH	rear right intermediate azimuth most critical case	U	SAS	FT 2	2b2.2d_t1	Snapshot test

Tests Ref. #	Test description	Conditions	Weight	Flight Control Mode	Validation source	Validation document POM reference	Comment
2.b.(3a)	LOW AIRSPEED LONGITUDINAL CONTROL RESPONSE	hover	U	ATT	FT 2	2b31.3n	
2.c.(1)	LONGITUDINAL CONTROL RESPONSE	cruise V_y	U	SAS	FT 2	2c1.5d1	
2.c.(2)	LONGITUDINAL STATIC STABILITY	cruise reference speed - ~20 kt	U	SAS	FT 2	2c2.5d_t1	Snapshot test
2.c.(3a)	LONGITUDINAL LONG TERM RESPONSE	cruise	U	SAS	FT 2	2c31.5d	Non-periodic response: see VDR Rationale 006
2.c.(3a)	LONGITUDINAL LONG TERM RESPONSE	cruise	U	ATT	FT 2	2c31.5n	
2.d.(3b)	SPIRAL STABILITY	cruise left direction	U	SAS			Impossibility of making evident spiral stability: see VDR Rationale 008
2.d.(3b)	SPIRAL STABILITY	cruise right direction	U	SAS			

– Weight: U: Undetermined; L: Low; H: High.
– Flight Control Mode: ATT for tests with stability augmentation ON; SAS (Training) mode for tests with stability augmentation OFF.
– Validation source: FT 1: test has been performed and source is from prototype helicopter flight tests; FT 2: test has been performed and source is from serial helicopter flight tests; Blank: test has not been performed: explanations are provided in comments column; ED: engineering data.
– Validation document: reference used to identify tests in POM document.
– Comments: additional explanations, which may link to rationales provided in the VDR.

Table D-2. Example of VDR rationale — 1

	VDR RATIONALE	**Reference:** **VDR Rationale 003** **Issue:** **A**

Subject: **Engine parameters validity during engine start tests**

Requirements	Title
1.a.(1).(i)	Engine start and acceleration

References:

Associated rationales:

Detail:

During engine start tests, different specific engine parameters have been measured.

Each sensor used for each engine parameter measurement has its own validity domain. For example, the measurement of a rotation speed (N_R, N_f) is made with a gear wheel and an electromagnetic counter operating at a clearly defined frequency range (counting the number of gears per time unit), which makes the measurement no longer valid below a certain rotation speed value.

In the following summary table the beginning of the measurement validity domain is provided for the major engine parameter sensors :

Parameter	Beginning of validity domain
Torque	N_f = 40%
Fuel flow	45 l/h
N_g	4 %
N_f	5 RPM
N_R	25 RPM

For the aforementioned parameters, all the values measured during engine start tests must be ignored when under the beginning of validity domain described above and so have been set to zero in the flight tests files in case of aberrant value.

Table D-3. Example of VDR rationale — 2

<table>
<tr><td colspan="2"></td><td>VDR
RATIONALE</td><td>Reference:
VDR Rationale 008
Issue:
A</td></tr>
<tr><td colspan="4">Subject: Impossibility of making evident spiral stability in SAS mode in the right direction</td></tr>
<tr><td>JAR Requirements</td><td colspan="3">Title</td></tr>
<tr><td>2.d.(3).(ii)</td><td colspan="3">Spiral Stability</td></tr>
<tr><td colspan="4">References:</td></tr>
<tr><td colspan="4">Associated rationales:</td></tr>
<tr><td colspan="4">Detail:

Despite several repetitions of the required test at different airspeeds and for different amplitudes of inputs, it has not been possible to make evident the spiral stability on this type of helicopter.

In this configuration, Dutch roll always masked the searched phenomena.

Dutch roll is an eigen mode with a rather high frequency in the [0.2 Hz, 0.3 Hz] range.

When the helicopter is in SAS mode, the manoeuvre initiation (release from pedal only or cyclic only turn) can be enough to make the roll and yaw oscillations start. Even if the Dutch roll is stable, the poor damping means that a long time is required to make the short-term oscillations vanish and allow demonstration of the long-term roll attitude change.

When the helicopter is in ATT mode, the flight is quickly stabilized with no significant flight parameters changes.

Therefore, no spiral stability test will be presented in the POM.</td></tr>
</table>

Attachment E

GUIDELINES FOR ADDITIONAL OR ALTERNATE ENGINES OR AVIONICS VALIDATION DATA

1. BACKGROUND

1.1 For a new helicopter type, the majority of flight validation data are collected on the first helicopter configuration with a baseline engine fit and a baseline avionics configuration. These data are then used to validate all FSTDs representing that helicopter type.

1.2 In the case of FSTDs representing a helicopter with a different engine fit than the baseline, or with a revised, or more than one, avionics configuration, additional test validation data may be needed.

1.3 When an FSTD with multiple engine fits is to be qualified, the QTG should contain test validation data for selected cases where engine differences are expected to be significant.

1.4 The primary engine fit for a given FSTD will be validated by running the entire QTG for that engine fit. Additional engine fits for that device will require only a subset of the QTG as defined in Section 2 of this attachment.

1.5 When an FSTD with an alternate avionics configuration is to be qualified, the QTG should contain test validation data for selected cases where the avionics configuration differences are expected to be significant as defined in Section 3 of this attachment.

1.6 The nature of the required complementary validation data (e.g. flight test data, engineering data) should be in accordance with the guidelines prescribed by Section 4 of this attachment, except where other data are specifically allowed (see Attachment B to this Part – *Engineering Simulation Validation Data*).

2. QTG GUIDELINES FOR THE QUALIFICATION OF ADDITIONAL ENGINE FITS

2.1 The following guidelines apply to FSTDs equipped with multiple engine types, power ratings or performance limits. The baseline engine fit for a given FSTD will be validated by running the entire QTG for that engine fit. To validate the implementation of additional engine types or power ratings or performance limits in that FSTD, a subset of the QTG should be provided together with a brief description of the change and impact. The test conditions (one per test number) in Table E-1 should be presented, as a minimum.

2.2 In general, the validation of FSTD configurations with differing rotor systems (rotor blade mass/structure, rotor disc area, nominal rotor velocity, etc.) require a more thorough validation of the aerodynamics of the helicopter and are thus not considered an alternate engine fit in accordance with this section. The FSTD operator should coordinate the FSTD data requirements in this situation in advance with the NAA.

2.3 Alternate engine differences can be grouped broadly into the following three categories:

2.3.1 **Simple variant:** engine make, model, rotor system (rotor speed, rotor mass, rotor disc area, etc.) and transmission are the same as for the baseline validated engine fit. Take-off or OEI performance limits (torque, temperature, and N_1 speed) are within ± 5 per cent of the baseline validated engine. Differences are typically limited to

FADEC performance (torque, temperature, etc.) and/or OEI limits. Validation testing is required only to demonstrate the correct implementation of FADEC performance limit differences.

2.3.2 **Normal variant:** engine make, model, rotor system (rotor speed, rotor mass, rotor disc area, etc.) and transmission are the same as for the baseline validated engine fit. Take-off or OEI performance limits (torque, temperature, or N_1 speed) differ by more than ± 5 per cent of the baseline validated engine. Reference torque value may differ from that of the baseline validated engine configuration.

2.3.3 **Alternate engine:** it consists in a different engine make and model. Rotor system (rotor speed, rotor mass, rotor disc area, etc.) and transmission are the same as for the baseline validated engine fit.

Table E-1. Minimum recommended list of additional engine QTG tests

TEST NUMBER	TEST DESCRIPTION	SIMPLE VARIANT	NORMAL VARIANT	ALTERNATE ENGINE
1.a.1.i	Engine start and acceleration (transient)		X[1]	X
1.a.1.ii	Steady state idle and operating RPM conditions		X[1]	X
1.a.2	Power turbine speed trim		X[1]	X
1.a.3	Engine and rotor speed governing		X[1]	X
1.c.1	All engines operating take-off	X[2]	X	X
1.c.2	One engine inoperative continued take-off	X[2]	X[3]	X[3]
1.c.3	One engine inoperative rejected take-off	X[2]	X[3]	X[3]
1.f	Level flight performance			
1.g	One engine inoperative climb performance	X[2]	X	X
1.i	Autorotational entry		X	X
1.j.1	All engines operating landing			X
1.j.2	One engine inoperative landing (CAT A and CAT B)	X[2]	X[3]	X[3]
1.j.3	Balked landing	X[2]	X[3]	X[3]

1. Test required only if significant differences are exhibited in the variant engine.
2. FSTD baseline tests validated with OEM (helicopter or engine manufacturer) supplied performance/engineering data will be acceptable to demonstrate take-off/landing performance limits.
3. Flight test validation required if testing was required for helicopter certification. Otherwise, FSTD baseline tests validated with OEM (helicopter or engine manufacturer) supplied performance/engineering data will be acceptable to demonstrate take-off/landing performance limits.

3. QTG GUIDELINES FOR THE QUALIFICATION OF ALTERNATE AVIONICS

3.1 The following guidelines apply to FSTDs representing helicopters with a revised, or more than one, avionics configuration.

3.2 The helicopter avionics can be segmented into those systems or components that can significantly affect the QTG results and those that cannot. The following avionics systems or components are examples of those for which hardware design changes or software revision updates may lead to significant differences relative to the baseline avionics configuration: flight-control computers and controllers for engines and autopilot. Related avionics such as stability augmentation systems should also be considered. The QTG should identify and substantiate the tests affected for each avionics system change.

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

3.4 For an avionics change which affects some tests in the QTG, but where no new functionality is added and the impact of the avionics change on helicopter response is a small, well-understood effect, the QTG may be based on validation data from the previously-validated avionics configuration. This should be supplemented with avionics-specific validation data with the revised avionics configuration from the data supplier. However, additional flight validation data may not be needed if the avionics changes were certified without need for testing with a comprehensive flight instrumentation package. The FSTD operator should provide a rationale explaining the nature of the change and its effect on the helicopter response.

3.5 For an avionics change which significantly affects some tests in the QTG, especially where new functionality is added, the QTG should be based on validation data from the previously-validated avionics configuration and supplemental avionics-specific test data, necessary to validate the alternate avionics revision, from the data supplier. However, additional flight validation data may not be needed if the avionics changes were certified without need for testing with a comprehensive flight instrumentation package. In this situation, the FSTD operator should coordinate FSTD data requirements in advance with the NAA.

3.6 For changes to an avionics system or component that do not affect the QTG, the test can be based on validation data from the previously validated avionics configuration. For such changes, it is not necessary to include a rationale.

4. VALIDATION DATA REQUIREMENT GUIDELINES FOR ALTERNATE ENGINE FITS AND AVIONICS SYSTEMS

4.1 For tests that are affected by difference in engine type as prescribed by paragraphs 2.1, 2.2 and 2.3, flight test data would be preferred to validate that particular helicopter-engine configuration.

4.2 If certification of the flight characteristics of the helicopter with a new engine type (regardless of percentage change in take-off power) does require certification flight testing with a comprehensive stability and control flight instrumentation package, then the list of tests detailed in Table E-1, as a minimum, should be obtained from flight testing and presented in the QTG. Flight test data are not required if the new alternate engine configuration is certified on the helicopter without need for a comprehensive stability and control flight instrumentation package. In this instance, alternate source data, such as engineering simulator and/or OEM performance data, may be used to validate the required test cases in the QTG.

4.3 Tests that are significantly affected by a change to the avionics configuration, as described in paragraph 3.5, should be supported by flight test data.

4.4 A matrix or VDR should be provided with the QTG indicating the appropriate validation data source for each test (see Attachment D to this Part). The FSTD operator should coordinate FSTD data requirements pertaining to alternate engines or avionics configuration in advance with the NAA.

Attachment F

FREQUENCY-DOMAIN MOTION CUEING SYSTEM PERFORMANCE TEST

1. BACKGROUND

1.1 The purpose of this attachment is to offer guidance on a new objective test which should be used to ensure motion cueing of FSTDs is consistently delivered in an acceptable manner. This guidance should help engineers involved in preparing for the test as well as National Aviation Authority inspectors involved in the evaluation of FSTDs using this test.

1.2 The purpose of this test is to objectively measure the frequency response of the complete motion cueing system for specified degree-of-freedom relationships. Other motion tests, such as the motion system frequency response, concentrate on the mechanical performance of the motion system hardware alone. The motions experienced by the pilot are highly dependent on the motion cueing algorithm, and its implementation in the FSTD. This test quantifies the response of the motion cueing system from the output of the flight model to the motion platform response.

1.3 The characteristics of the motion cueing system have a direct impact on the perception and on the control exercised by the pilot in the FSTD, especially during manual flying. The pilot's appreciation of the FSTD fidelity is considerably dependent on the perceived "feel" of the simulated aircraft, and this feel is influenced by the motion cueing system, among others. The first element in the motion cueing system is the Motion Drive Algorithm (MDA), a set of control blocks that transform the outputs from the flight model to motion platform commands. A block diagram of the basic scheme of a motion cueing algorithm is shown in Figure F-1.

1.4 In Figure F-1, the HP filter and LP filter indicate High-Pass and Low-Pass filters, respectively. The scaling factors, f-scale and ω-scale, are chosen in order:

- to provide the pilot with motion cues to maintain his perception and control behaviour as much as possible equal to that in real flight; and
- to keep the simulator motions within the motion space of the motion system.

1.5 In order for the simulator to provide a feel that is representative of the aircraft, the MDA parameters are tuned during acceptance by the evaluation pilot under different conditions. Usually, the evaluation pilot's subjective feel is used to tune the motion cueing system. This however does not lead to a consistently reliable and reproducible tuning of the cueing system mostly because of variability in preferences across pilots and also variability of feel for the same pilot over different days.

1.6 Invariably, compromises must be made in order to provide motion cues that feel reasonable, while keeping the motion platform within its fixed boundaries. The gains are therefore attenuated throughout the frequency range. In this sense, the Motion Cueing System (MCS) includes the following:

1) the motion cueing algorithm;

2) the motion platform actuator extension transformation and control laws;

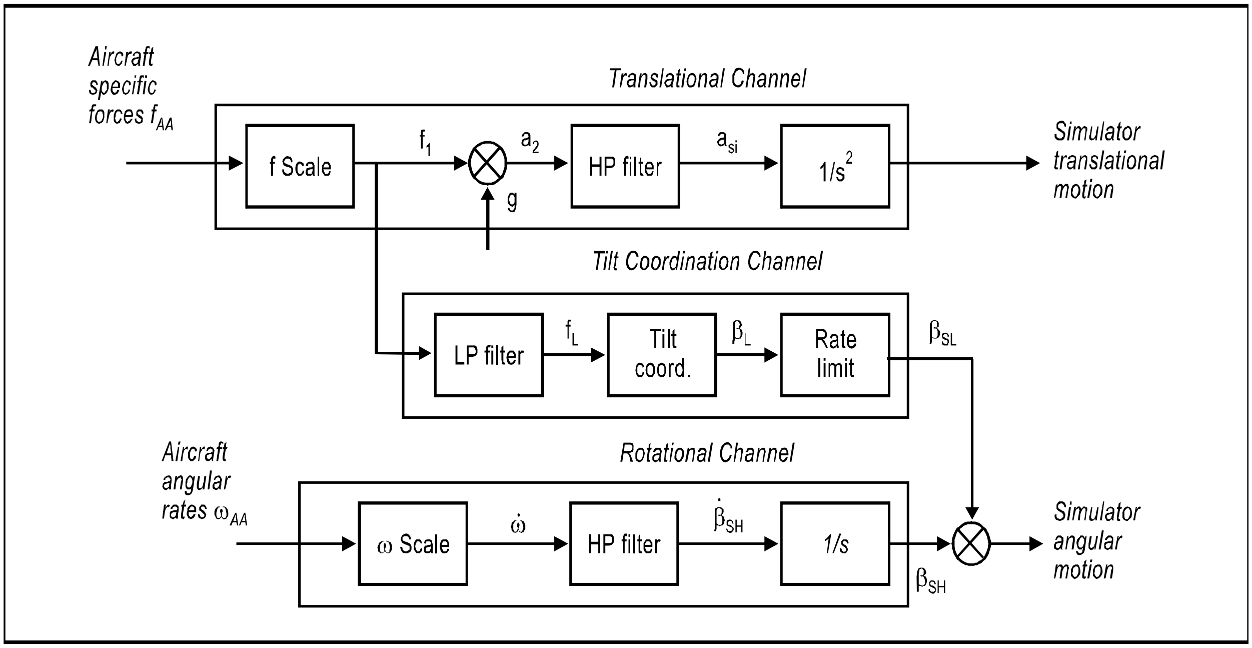

Figure F-1. Basic scheme of a motion cueing algorithm (from Reid-Nahon)[1]

3) the motion platform hardware, that reacts to these transformed aircraft motion commands; and

4) the digital time delay embedded in the above processes.

1.7 Analogue processes have a modulus and a phase which includes the analogue delays. When these analogue processes are simulated digitally, an additional digital time delay is introduced.

1.8 All of the above influence the pilot's perception of the simulated motion. In order to compare and evaluate motion systems in a more rigorous manner, an Objective Motion Cueing Test (OMCT) is described herein.

1.9 For this test, it is important that the "reference" signals are defined at the location of the pilot F_{PA} in the aircraft, and not at the aircraft CG (CG_{AC}). It is important because this is what the pilot feels when in his seat. The simulator response is measured at the pilot position F_{PS} in the simulator. The response at F_{PS} should be compared with the signal at F_{PA}. This provides information on the transformation of the aircraft motions to simulator motions as perceived by the pilot, and is shown in the signal diagram of Figure F-2. The measured frequency response of the motion cueing system describes the relation between the responses measured at ❶ compared to the input at ❷, with the "switch" in Figure F-2 in the down position. The signals generated by the OMCT signal generator are described below.

Note.— The relevant reference frames, such as F_{PA} and F_{PS}, are described in paragraph 7.4.

1. Reid L.D. and Nahon M.A. (1986) Flight Simulation Motion-Base Drive Algorithms: Part II – Selecting the System Parameters. UTIAS Report No. 307, University of Toronto.

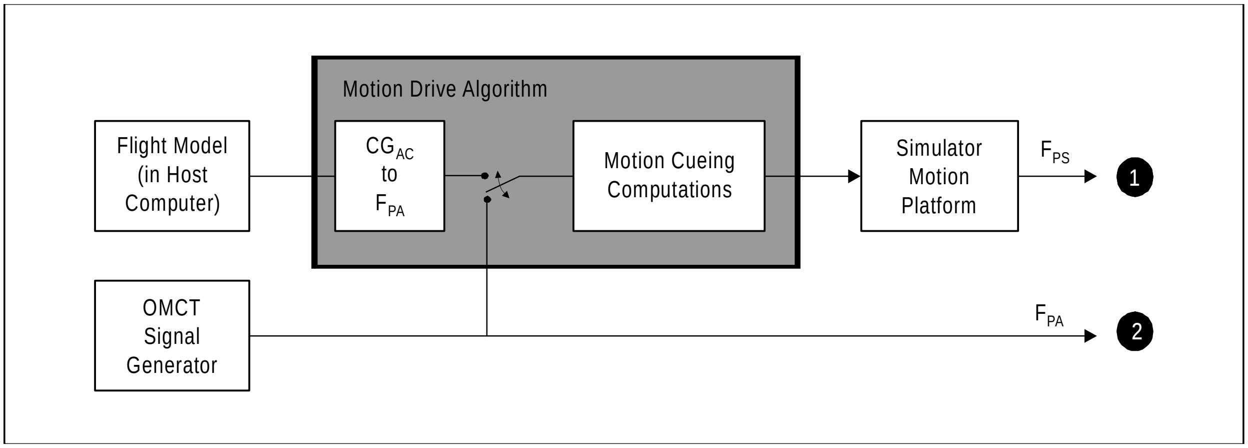

Figure F-2. Transformation from simulated aircraft flight model output to motion platform response

1.10 The MDA is defined here as all the processes needed to transform the F_{PA} motions to simulator motion platform response F_{PS}. It includes the motion cueing algorithm as applied in the operational use of the training device, including all special effects and buffet computations, actuator inverse transformations and the control laws needed to command the closed-loop motions of the platform. This OMCT considers all these aspects as a whole in order to also capture the transport delays introduced by these processes and by the related computer equipment used in the motion system. In some cases the MDA may be integrated in the host computer and in other cases it may be part of the motion control computer.

1.11 The simulator motion platform is defined as the mechanical hardware used to generate the motions.

1.12 The criterion on which this test is based states that, over the finite frequency range important for manual control, the modulus of the total system should be high (close to 1) and the phase should be small (close to zero) for the direct transformation and some of the cross-coupling relations, in order to simulate the aircraft motions as realistically as possible. Hence, this test is set up to evaluate the modulus and phase of the simulator over the defined frequency range against this criterion.

1.13 The ideal simulator would provide rotations and translations as they would occur in the aircraft. However, due to the limitations of the motion platform, this is physically not possible. As a result, simulator translations and rotations are used in a mixed manner to create the effect of both aircraft rotations and translations. From the motion stimulation and pilot perception point-of-view, the following frequency responses have been defined as being of direct importance for the OMCT:

1) simulator rotational response due to aircraft pure rotational manoeuvres;

2) simulator specific force response due to aircraft pure translational manoeuvres;

3) simulator rotational accelerations due to aircraft pure translational manoeuvres; and

4) simulator translational response to aircraft pure rotational manoeuvres.

1.14 The first two relations are of direct importance for the correct simulation of motions. In the frequency range of importance to manual flying, these require a high gain with respect to the aircraft motions, and a small phase distortion. The other two relations (3 and 4) provide information about the cross-coupling of the simulator motion response and may be used to create the illusion of the aircraft environment.

2. OBJECTIVE MOTION CUEING TEST PROCEDURE

2.1 This test is to be conducted in up to two configurations separately, representing the motion cueing algorithm settings in hover, and again in forward flight. If these settings are not changed between hover and forward flight on the simulator in question, then a single set of tests is acceptable.

2.2 *Measurement Frequencies*. The purpose of these tests is to determine the frequency response of the complete motion cueing system for the four relations described above. For these measurements, the frequencies of the input signals are given in Table F-1.

Note.— In Table F-1, the frequency given in Hertz is that corresponding to the frequency in rad/s, and is only shown for reference.

2.2.1 The relationship between the frequency and corresponding modulus M and the corresponding phase ϕ defines the system frequency response. This test requires that for each degree-of-freedom, measurements at 12 discrete frequencies are taken.

2.2.2 During the OMCT, for the measurements required, the individual degrees of freedom are excited independently for pitch, roll and yaw and modified inputs are given for the surge, sway and heave (described below). For each discrete input frequency defined in Table F-1, the measured relation in modulus and phase should be shown. This can be done manually (by measuring amplitude and phase on the resulting plots like Figure F-3), or by using appropriate digital methods.

2.2.3 The modulus M and phase ϕ are defined as:

M (ω) = amplitude of output u (ω)/ amplitude of input i (ω)

$$\phi(\omega) = \Delta t\ \omega\ 360 / 2\pi \quad [°] \qquad [1]$$

Note.— A description of symbols and notations is provided in Figure F-3 and in paragraph 7.

Table F-1. Input test signal frequencies and required modulus and phase measurements

Input Signal Number	*Frequency [rad/s]*	*Frequency [Hertz]*	*Modulus M [dimension: see Table F-5]*	*Phase ϕ [°]*
1	0.1	0.0159		
2	0.158	0.0251		
3	0.251	0.0399		
4	0.398	0.0633		
5	0.631	0.1004		
6	1	0.1591		
7	1.58	0.251		
8	2.51	0.399		
9	3.98	0.633		
10	6.31	1.004		
11	10	1.591		
12	15.8	2.515		

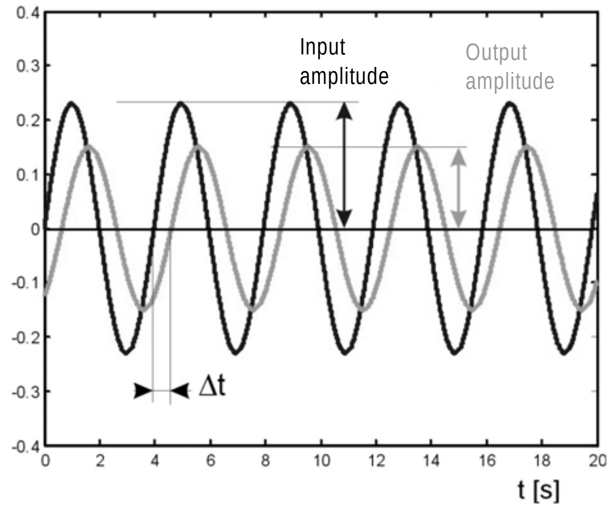

Figure F-3. General definition of amplitudes of an output signal *u* and input signal *i* and time shift *Δt* between *u* and *i*

3. INPUT AMPLITUDES

3.1 A key goal of the MDA is to generate motion responses while maintaining the platform within its mechanical limits. In order to test the motion cueing system in the region important to manual control, the input amplitudes are defined.

3.2 The tests applied to the motion cueing system are intended to quantify its response to normal control inputs during manoeuvring (i.e. not aggressive or excessively hard control inputs) with linear response in order to maintain consistency. It is however necessary to excite the system in such a manner that the response is measured with a high signal-to-noise ratio, and that the possible non-linear elements in the motion cueing system are not overly excited.

3.3 In order to carry out these tests, a specific test signal is entered into the motion cueing system as shown in Figure F-2 at Point ❷. These tests stimulate the motion cueing system in a way similar to the aircraft model output in the FSTD. The test signal represents the aircraft state variables ($\varphi_{a/c}$, $\theta_{a/c}$, $\psi_{a/c}$, $f_{a/c}^{x}$, $f_{a/c}^{y}$ and $f_{a/c}^{z}$). These variables should correspond to those normally applied in the particular motion cueing system. In other words, if the FSTD manufacturer uses the angular rates instead of attitudes, the corresponding input signals have to be generated.

3.3.1 *Specific force input amplitudes*. In the specific force channels, the input signal is defined by Equation 2 and the amplitudes are given in Table F-2.

$$f_{a/c}^{x,y,z}(t) = A \sin(\omega t) \qquad [2]$$

Table F-2. Specific force input amplitudes

Frequency Signal Number	*Frequency [rad/s]*	*Frequency [Hz]*	*Amplitude A [m/s^2]*
1	0.100	0.0159	1.00
2	0.158	0.0251	1.00
3	0.251	0.0399	1.00
4	0.398	0.0633	1.00
5	0.631	0.1004	1.00
6	1.000	0.1591	1.00
7	1.585	0.251	1.00
8	2.512	0.399	1.00
9	3.981	0.633	1.00
10	6.310	1.004	1.00
11	10.000	1.591	1.00
12	15.849	2.515	1.00

3.3.2 *Rotational input amplitudes*. For the rotational inputs, the relations between attitude, angular rate and acceleration are given in Table F-3, and the corresponding amplitudes in Table F-4. These equations are only valid for ω in rad/s. The tests may be carried out with attitude, angular rate or angular acceleration inputs, as long as the inputs are consistent with the MDA implemented in the simulator.

Table F-3. Rotational input amplitudes

	Aircraft pitch	*Aircraft roll*	*Aircraft yaw*
Attitude	$\theta_{a/c}(t) = A \sin(\omega t)$	$\varphi_{a/c}(t) = A \sin(\omega t)$	$\psi_{a/c}(t) = A \sin(\omega t)$
Angular rate	$q_{a/c}(t) = A \omega \cos(\omega t)$	$p_{a/c}(t) = A \omega \cos(\omega t)$	$r_{a/c}(t) = A \omega \cos(\omega t)$
Angular acceleration	$\dot{q}_{a/c}(t) = -A \omega^2 \sin(\omega t)$	$\dot{p}_{a/c}(t) = -A \omega^2 \sin(\omega t)$	$\dot{r}_{a/c}(t) = -A \omega^2 \sin(\omega t)$

Table F-4. Rotational input amplitudes given by attitude, angular rate or acceleration

Frequency Signal Number	*Frequency [rad/s]*	*Frequency [Hz]*	*Attitude amplitude A [°]*	*Angular rate amplitude A ω [°/s]*	*Angular acceleration amplitude A ω^2 [°/s^2]*
1	0.100	0.0159	6.000	0.600	0.060
2	0.158	0.0251	6.000	0.948	0.150
3	0.251	0.0399	3.984	1.000	0.251
4	0.398	0.0633	2.513	1.000	0.398
5	0.631	0.1004	1.585	1.000	0.631
6	1.000	0.1591	1.000	1.000	1.000
7	1.585	0.251	0.631	1.000	1.585
8	2.512	0. 399	0.398	1.000	2.512
9	3.981	0.633	0.251	1.000	3.981
10	6.310	1.004	0.158	1.000	6.310
11	10.000	1.591	0.100	1.000	10.000
12	15.849	2.515	0.040	0.631	10.000

4. OMCT TEST MATRIX

The OMCT requires the frequency response to be measured for the motion cueing system from the pilot reference position in the aircraft F_{PA} to the pilot reference position in the simulator F_{PS} for the transformations defined in Table F-5. Six independent tests (one for each Aircraft Input Signal) should be performed. Tests 1 and 2, tests 3 and 4, tests 6 and 7, and tests 8 and 9 are to be conducted with one input signal while measuring two output responses, simultaneously. The reason for this is to measure both the direct responses and cross-coupling responses in one test.

Table F-5. Test matrix with test numbers
(the modulus of the frequency response of the off-diagonal elements
[in the shaded cells] has a dimension;
the modulus of the diagonal elements is non-dimensional)

	Simulator Response Output					
Aircraft Input Signal	**Pitch**	**Roll**	**Yaw**	**Surge**	**Sway**	**Heave**
Pitch	**1**			**2**		
Roll		**3**			**4**	
Yaw			**5**			
Surge	**7**			**6**		
Sway		**9**			**8**	
Heave						**10**

5. OMCT TEST DESCRIPTIONS

5.1 The frequency responses describe the relations between aircraft motions and simulator motions as defined in Table F-5. The relations are explained below per individual test:

1) FSTD pitch response to aircraft pitch input;

2) FSTD surge translation response due to aircraft pitch input;

3) FSTD roll response to aircraft roll input;

4) FSTD sway translation response due to aircraft roll input;

5) FSTD yaw response to aircraft yaw input;

6) FSTD surge response to aircraft surge input;

7) FSTD pitch rate and pitch acceleration response to aircraft surge input;

8) FSTD sway response to aircraft sway input;

9) FSTD roll rate and pitch acceleration response to aircraft sway input; and

10) FSTD heave response to aircraft heave input.

5.2 Tests 1, 3, 5, 6, 8 and 10 show the direct transfer relations, while tests 2, 4, 7 and 9 show the cross-coupling relations.

6. PRESENTATION OF RESULTS

6.1 The results should be presented for each of the OMCT tests defined in Table F-5, and at each frequency defined in Table F-1, in terms of the modulus and phase. Hence, for each of the ten tests described above, a table should be presented, with twelve rows (one for each frequency). The results should also be plotted for each component in the test matrix of Table F-5, ranging from 0.0 to 1.0 for the modulus along the horizontal axis, and from 0 to 180 degrees for the absolute value of the phase along the vertical axis. An example response is shown in Figure F-4. Each of the tests defined in paragraph 5.1 yields such a plot. In Figure F-4, the responses of two motion systems are also shown, indicating how it is possible to distinguish their relative ability to reproduce the aircraft motions.

6.2 As these tests show the modulus and phase introduced by the simulator motion cueing system, the criterion on which the OMCT is based stipulates that it is important to achieve a relatively high modulus and a relatively low phase. It is possible to immediately use the technique to compare the motion cueing performance between simulators. It is expected that a minimum boundary for the modulus and a maximum boundary for the phase will be defined, whereby motion cueing systems that fall within these boundaries will be qualified, while those outside may require modification by the FSTD manufacturer or operator. The boundaries are illustrated in Figure F-4 (modulus from 0.5 to 1.0 and phase from 0° to 50°). Definition of acceptability bounds is an ongoing activity and will be addressed by the ICFQ.

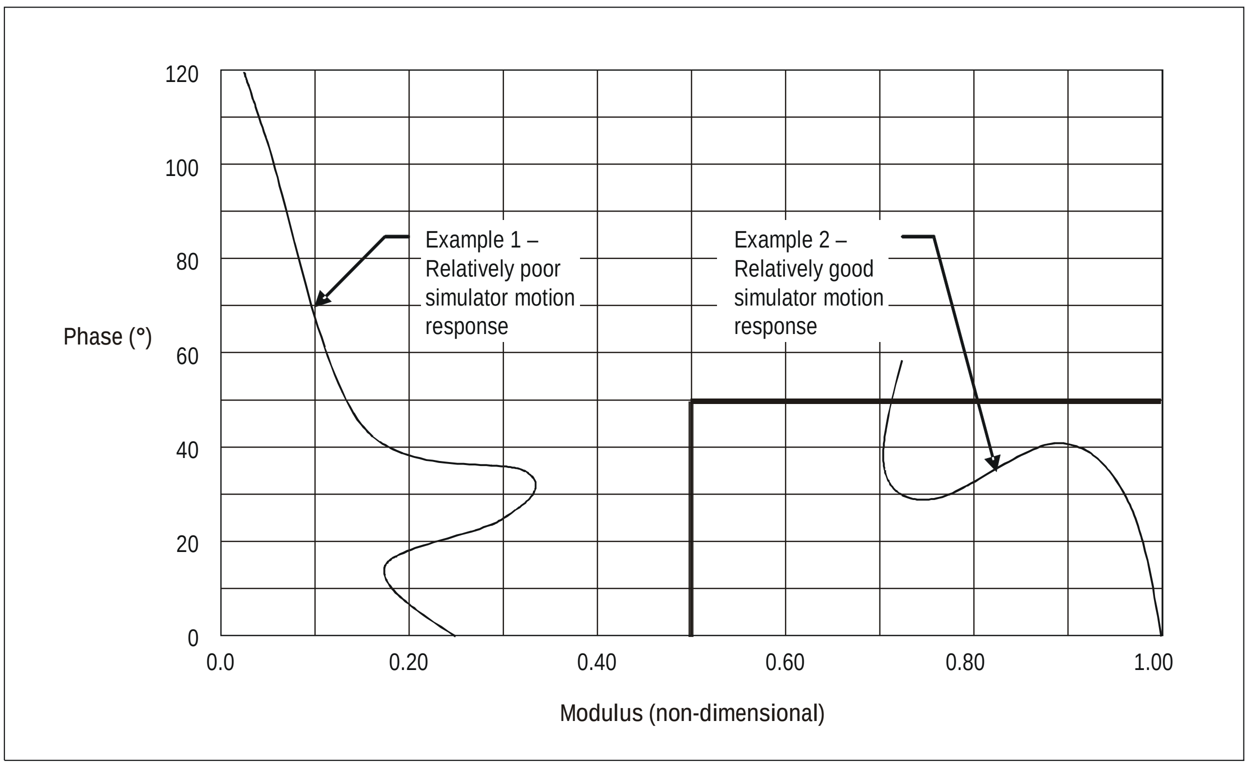

Figure F-4. Example of an OMCT plot, showing also relative differences in responses between a poor and a good motion cueing system

6.3 The examples shown in Figure F-4 do not represent actual measurements and are only shown to indicate the merit of the test results. In example 1, the line showing the combined response of the motion cueing, motion system and motion transport delay has a relatively low gain and large phase range. The opposite is true for the line of example 2. The parasitic motions (tests 2, 4, 7 and 9 from Table F-5) should have a relatively low gain. Over a specified frequency range, the correct direct motions (tests 1, 3, 5, 6, 8 and 10 from Table F-5) should have a relatively high gain and low phase.

7. NOTATIONS AND FRAMES OF REFERENCE

7.1 Notations

θ	pitch angle	[°]
φ	roll angle	[°]
ψ	yaw angle	[°]
ω	frequency	[rad/s]
ϕ	phase angle	[°]
A	amplitude	
M	Modulus	
a	linear acceleration	[m/ s^2]
f	specific force	[m/ s^2]
g	gravity	[m/ s^2]
i	input signal	
p	roll rate	[°/s]
q	pitch rate	[°/s]
r	yaw rate	[°/s]
u	output signal (or response)	
t	time	[s]
Δt	measured phase delay	[s]

7.2 Sub-indices

A	aircraft
AC	aircraft
a/c	aircraft
PA	aircraft pilot
PS	simulator pilot
S	simulator

7.3 Upper indices

x, y, z along X, Y, and Z axis, respectively.

7.4 Frames of Reference

In order to ensure that the results are consistent between simulators, the following frames of reference are defined.

Frame F_D

Reference frame F_D is located with its origin at the centre of the motion measurement system that may be used in these tests. The x-axis points forward, and the z-axis points downward. The x-y plane is parallel to the upper simulator frame which will be assumed to be parallel to the floor of the cockpit. Note that F_D is not explicitly shown in Figure F-5.

Frame F_I

The inertial reference frame F_I is fixed to the ground with the z-direction aligned with the gravity vector g. This frame is often used in the MDA.

Frame F_S

The simulator reference frame F_S has its origin at a reference point selected to suit the manufacturer's motion drive algorithm. It is attached to the simulator cab and is parallel to frame F_D. Its origin may be coincident with F_D.

Frame F_A

The aircraft reference frame F_A has its origin at the aircraft centre of gravity. Frame F_A is parallel to frame F_D. Frame F_A has the same orientation with respect to the cockpit as the simulator frame F_S.

Frame F_{PS}

This is a frame attached to the simulator in the plane of symmetry of the cab, at a height approximately 35 cm below eye height. The x-axis points forward and the z-axis is downward. F_{PS} is parallel to F_D.

Frame F_{PA}

This is the same as F_{PS}, but for the aircraft pilots.

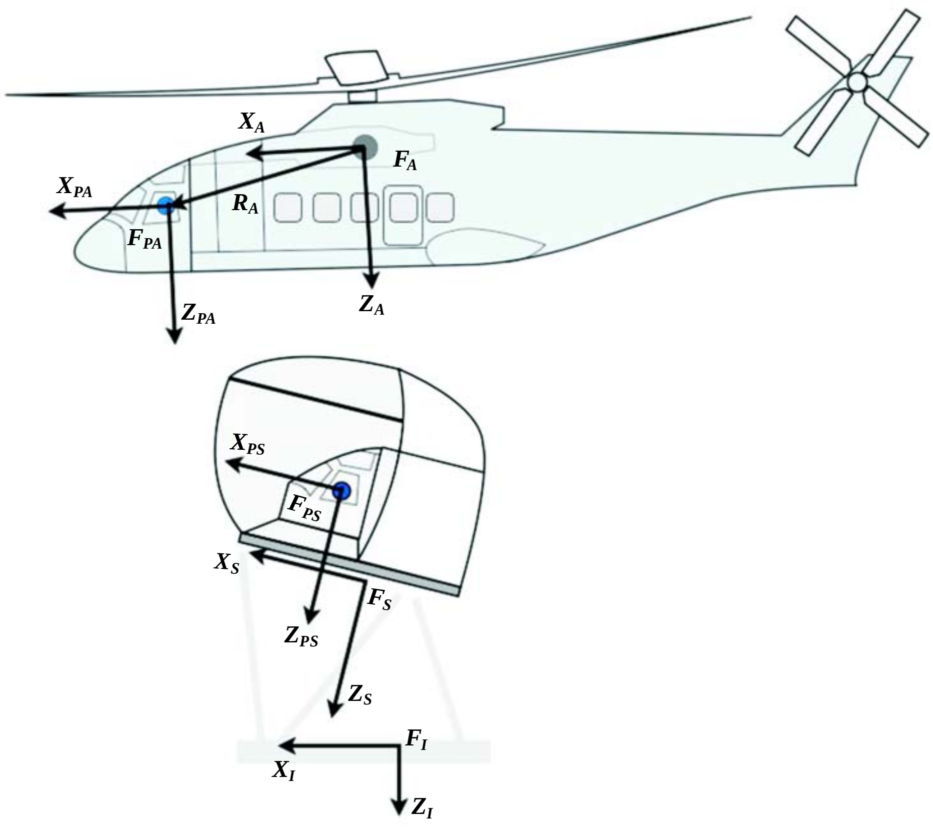

Figure F-5. Aircraft and simulator frames of reference relevant to MDAs

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Attachment G

TRANSPORT DELAY AND LATENCY TESTING

1. BACKGROUND

1.1 The purpose of this attachment is to provide guidance on the methods for conducting transport delay and latency tests.

1.2 The transport delay test has become the primary method for determining the delay introduced into the FSTD due to the time taken for the computations through the FSTD controls, host, motion and visual computer modules. The transport delay test is not dependent upon flight test data, but may require avionics computer and instrument data from the data supplier for some cases described below.

1.3 The latency test is a second method that remains acceptable as an alternate means of compliance. Figure G-1 presents the principal of transport delay and latency testing.

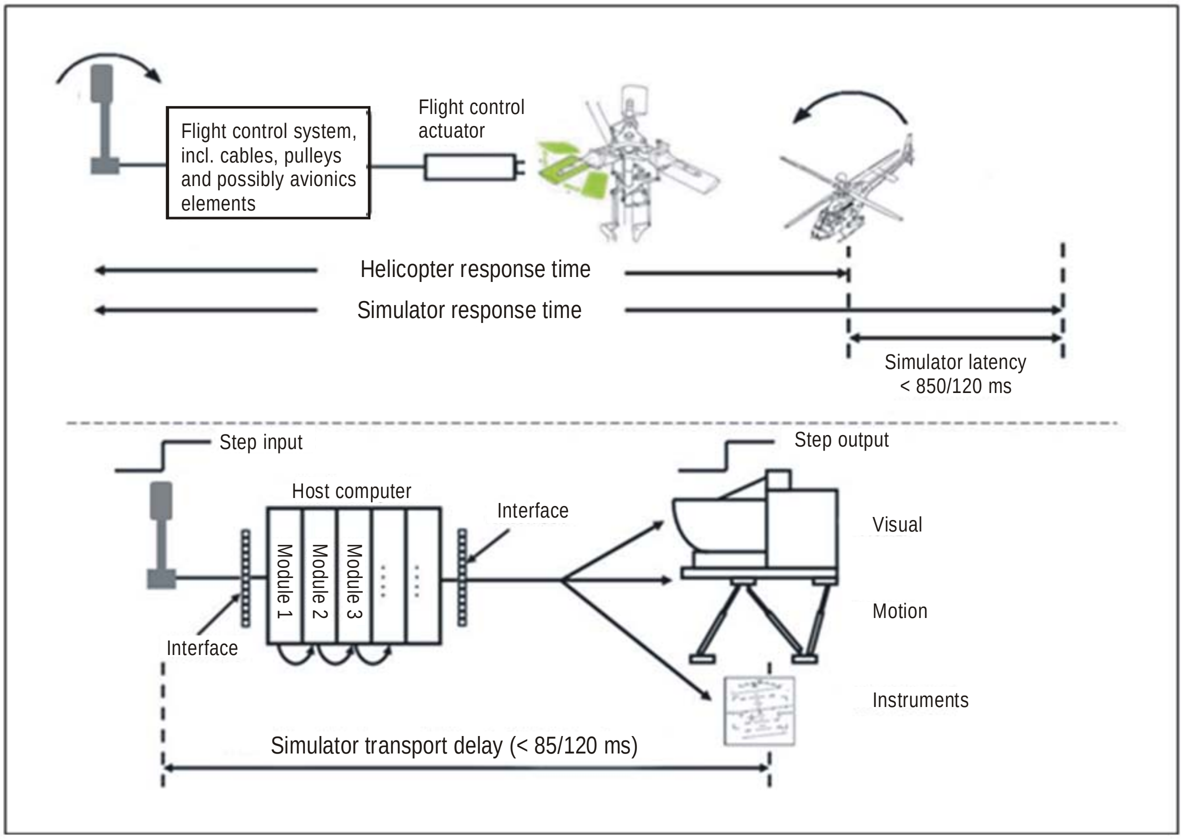

Figure G-1. Transport delay and latency testing

2. TRANSPORT DELAY

2.1 *Purpose*. This attachment describes how the introduced transport delay through the FSTD system should be measured and demonstrated not to exceed a specific time. The intention of the transport delay test is not to be compared with the helicopter but to demonstrate acceptable performance of the simulation at initial qualification, and then to be used as a non-regression test for the software architecture at each recurrent qualification. The transport delay must be measured from the control inputs through the interface, through each of the host computer modules and back through the interface to motion, flight instrument and visual systems, and shown to be no more than the tolerances required in the validation test tables.

In all cases, the simulation has been demonstrated to be dynamically equivalent to the helicopter in terms of response by the many dynamic tests in the QTG as well as the subjective handling tests, both for short-term and long-term modes. It is therefore only necessary to measure the maximum increased time added by the various interfaces and computing elements in the simulator that are not present in the helicopter. To do this, a signal is processed through the entire system from the input to the first interface from the control column or stick, through each subsequent computing element or interface and back out to the physical feedback to the pilot, via the motion system, visual system or cockpit instruments. To make this signal more traceable, a handshaking method may be used from element to element such that a clear leading edge is visible at any point through the system. However it should be noted that the signal must be passed through each element of the software and hardware architectures and that the simulation should be running in its normal mode with all software elements active. This is to ensure that the test may be re-run at subsequent requalifications to check that software modifications have not modified the overall path length. A full description of the method chosen and the path of the signal, as well as the input and recording points, should be provided.

The test result analysis requires only that the input and output signals be measured to be separated by no more than 85/120 ms, according to the type of FSTD. The point of movement will be very simple to determine since both input and output signals will have clear leading edges.

2.2 *Non-computer-controlled helicopters*. In the case of classic, non-computer-controlled helicopters, no further analysis will be necessary.

2.3 *Computer-controlled-helicopters*. For FSTDs of helicopters with electronic elements in the path between input from the pilot and resulting output, the measured transport delay in this case will obviously include elements of the helicopter itself. These may include flight control systems, avionics or display systems. Since the intention of the transport delay method is to measure only the time specific to the FSTD, and not that of the helicopter, the test result time should be offset by the throughput time of these avionics elements. This throughput time should be based on data from the manufacturer of the helicopter or avionics. Alternatively the helicopter equipment may be bypassed, provided that the signal path is maintained in terms of FSTD interfaces. A schematic diagram should be provided to present that part of the helicopter equipment being considered in this manner, and the way in which the signal path has been treated to be representative of all the simulation elements.

For FSTDs on which the avionics elements in question are replaced by re-hosted, re-targeted or other similar solutions, it is still necessary to offset the test result by the equivalent time of the helicopter elements. However the schematic diagram must in this case demonstrate the equivalence of the simulated avionics to the real avionics in terms of architecture, and if this cannot be done (reverse engineered avionics simulation, for example) then the control signal should be passed through the various modules of the avionics simulation as described above, using the hand-shaking method if required to ensure signal readability.

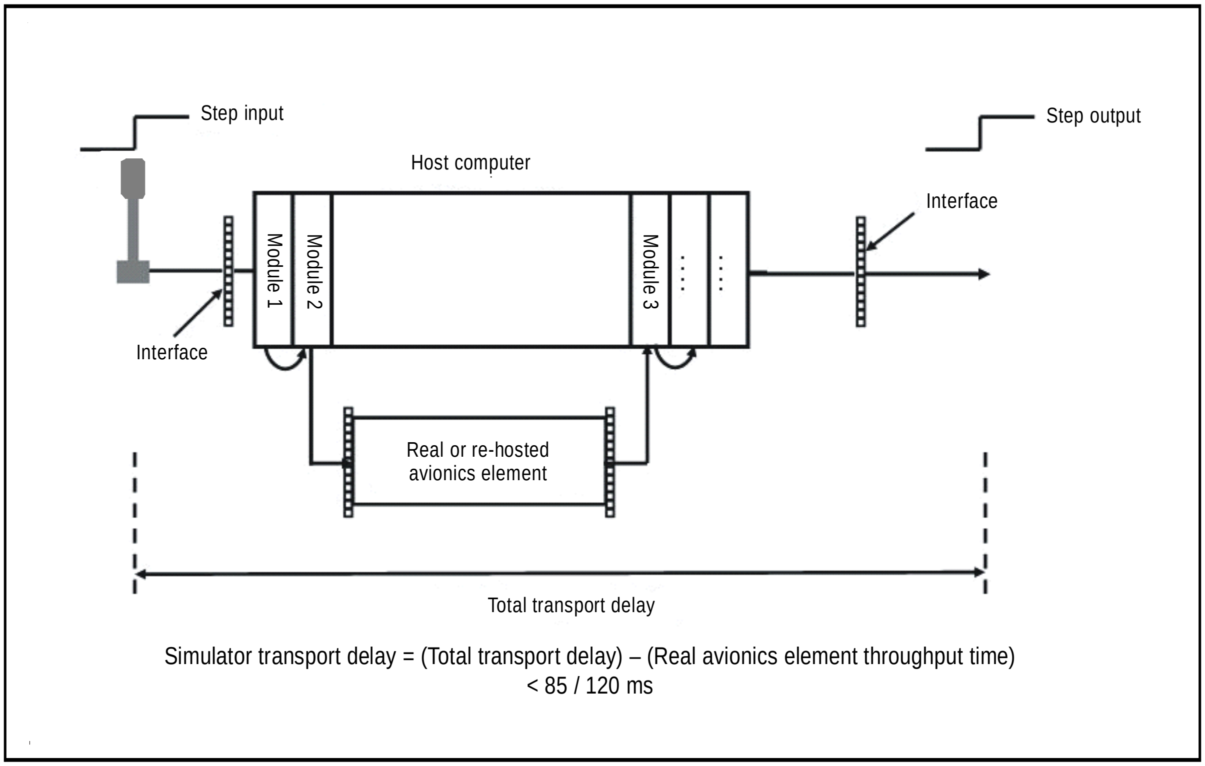

Figure G-2. Transport delay with avionics elements

2.4 *Interpretation of results*. It is normal that FSTD results vary over time from test to test. This can easily be explained by a simple factor called "sampling uncertainty." FSTDs may run at a specific rate with all modules executed sequentially in one or more host processors. The flight controls input can occur at any time in the iteration, but these data will not be processed before the start of the new iteration. For an FSTD running at 60 Hz, a worst-case difference of 16.67 ms could be expected. Where multiple parallel processors or priority-based execution systems are used, the scatter may be greater. Moreover, in some conditions, the host FSTD and the visual system do not run at the same iteration rate, therefore the output of the host computer to the visual will not always be synchronized.

When offsetting the measured results by the throughput time of the avionics elements, it is also necessary to recognize that digital equipment will normally give a range of response times dependent upon the synchronization of the control input with the internal equipment frame time. The helicopter or avionics manufacturer must quantify the range of results that should be expected by providing minimum and maximum response times, as well as an indication of the statistical spread in this range. It may be necessary to run the test several times on the FSTD to demonstrate the correctness of the avionics simulation in these conditions.

2.5 *Recorded signals*. The signals recorded to conduct the transport delay calculations should be explained on the schematic block diagram. An explanation of why each signal was selected, and how it relates to the descriptions above, should also be provided.

2.6 *Visual system modes*. The transport delay test should account for both daylight and night modes of operation of the visual system. In both cases, the tolerance is as required in the validation test tables, and motion response needs to occur before the end of the first video scan containing new information. Where it can be demonstrated that the visual system operates at the same execution rate for both day and night modes, a single test in each axis is sufficient, backed up by a supporting statement.

3. LATENCY

3.1 The purpose of this section is to provide guidance on how FSTD latency tests should be conducted and how measurements should be taken. The description below is for the classic non-computer controlled helicopter case.

3.2 Nine latency tests are required. Tests are required in roll, pitch and yaw axes for the take-off, cruise and approach or landing configurations. The tolerances employed are the same as those specified for the transport delay tests. Flight test data are required to support these tests.

3.3 The objective of the test is to compare the recorded response of the FSTD to that of the actual helicopter data in the take-off, cruise and approach or landing configuration for abrupt pilot control inputs in all three rotational axes. The intent is to verify that the FSTD system response time beyond the helicopter response time (as per the manufacturer's data) does not exceed the tolerances required in the validation test tables and that the motion and visual cues relate to actual helicopter responses. To determine helicopter response time, acceleration in the appropriate corresponding rotational axis is preferred.

3.4 Because the test tolerance is a small time value measured in ms, it is essential that helicopter and FSTD responses be measured accurately to enable a meaningful test result.

3.5 *Helicopter response time*

3.5.1 This test is a timing check of the motion, visual system and cockpit instruments to check the computational delay of the FSTD computer architecture. As helicopter data are employed as the benchmark, it is necessary to establish the helicopter response time for each test case to enable the FSTD response time to be isolated.

3.5.2 It is difficult to establish when the helicopter will have first moved as the result of the pilot control input in the selected axis, as the control input is unlikely to have been a step input. In order to establish a clear methodology for determining the initial helicopter movement for the purpose of this test, it has been necessary to define the initial movement as the point when the angular acceleration in the appropriate axis reaches 10 per cent of the maximum angular acceleration experienced. The elapsed time between the pilot control input and the helicopter reaching 10 per cent of its maximum acceleration in ms should be used as the helicopter response time.

3.6 *FSTD response time — Motion*. The FSTD response time for motion will be the elapsed time in ms between the pilot control input and the first discernable motion movement recorded by the accelerometers mounted on the motion platform. The latency for the motion system will be the FSTD response time (motion) minus the helicopter response time in ms. This time is subject to the test tolerance.

3.7 *FSTD response time — Visual system*. The FSTD response time for visual system will be the elapsed time in ms between the pilot control input and the first discernable visual change measured as appropriate for the visual system. The latency for the visual system will be the FSTD response time (visual system) minus the helicopter response time in ms. This time is subject to the test tolerance.

Note.— Visual system response time is measured to the beginning of the frame in which a change occurs.

3.8 *FSTD response time — Cockpit instrument*. The FSTD response time for cockpit instrument will be the elapsed time in ms between the pilot control input and the first discernable change measured as appropriate on the selected cockpit instrument. The latency for the cockpit instrument will be the FSTD response time (cockpit instrument) minus the helicopter response time in ms. This time is subject to the test tolerance.

3.9 *Computer controlled helicopters and other special cases*. Guidance already provided above for the transport delay tests for computer controlled helicopters and other special cases can be applied to the latency tests.

Attachment H

RECURRENT EVALUATIONS — PRESENTATION OF VALIDATION TEST DATA

1. BACKGROUND

1.1 During the initial evaluation of an FSTD the MQTG is created. This is the master document, as amended, to which FSTD recurrent validation test results are compared.

1.2 Part II, Chapter 2, Section 2.5 of this document describes the process for evaluation of validation test results for both initial and recurrent evaluations. The process will vary depending on the fidelity level of the FSTD feature being evaluated. Establishment of the MQTG is an important step in preparation for subsequent recurrent evaluations. Where the fidelity level is S, the approved data remain the baseline for recurrent evaluations. Where fidelity levels are G or R, with possible exceptions for sound and motion (see paragraph 1.3.2 below) the MQTG is a record of the reference data standard established during the initial evaluation and is the baseline for subsequent recurrent evaluations.

1.3 The currently accepted method of presenting recurrent validation test results is to provide FSTD results overplotted with either approved data or the reference data standard. Test results are carefully reviewed to determine if the test is within the Appendix B tolerances. This can be a time-consuming process, particularly when the data exhibit rapid variations or for an apparent anomaly requiring engineering judgment in the application of the tolerances. In these cases, the solution is to compare the results to the MQTG and if they are the same, the test is accepted. Both the FSTD operator and the NAA are looking for any variance in FSTD validation test results since initial qualification.

1.3.1 Where the fidelity level is R and S and small deviations from the MQTG are seen, the test result may still be acceptable if the test is within the Appendix B tolerances when measured against the approved data.

1.3.2 Where the fidelity level is R, for Type V sound and motion only:

a) in cases where approved subjective development has not been used and small deviations from the MQTG results are seen, the test result may still be acceptable if the test is within the Appendix B tolerances when measured against the approved data; and

b) in cases where approved subjective development has been used, the test result will be acceptable if the test is within the Appendix B tolerances when measured against the MQTG or reference data standard.

1.3.3 Where the fidelity level is G the test result will be acceptable if the test is within the Appendix B tolerances when measured against the MQTG or reference data standard.

2. PRESENTATION OF RECURRENT EVALUATION TEST RESULTS

2.1 The method described below to present recurrent validation test results is offered solely to promote more efficiency for operators while conducting recurrent FSTD validation testing. The efficiency gain arises from the ability to immediately identify, regardless of the experience of the individual conducting or assessing the test, any variance between the MQTG and recurrent validation test results. This method may only be practically used when the FSTD uses automatic testing which is strongly recommended to demonstrate consistent repeatability of validation test results.

2.2 FSTD operators are encouraged to overplot recurrent validation test results with MQTG results. As every MQTG test result is essentially a "foot-print" test for the FSTD, any variance in a validation test result will be readily apparent. A variance occurring in an established FSTD is probable indication of change. Unless there has been a software modification or hardware change, the variance may indicate hardware wear or some other drift or degradation issue. A consistent recurrent validation test result that differs from the MQTG for a new FSTD may indicate the MQTG test is at fault and should be updated. This should normally only occur during the first recurrent evaluation(s).

2.3 The operator should have the capability to overplot the recurrent result against the MQTG result or the approved data. Plotting capability should be available for both automatic (if applicable) and manual validation test results.

2.4 For all FSTD types, any variations between recurrent evaluation test results and MQTG test results are a probable indication of change. Investigation of any variance between the MQTG and recurrent FSTD performance should be conducted, particularly if these variations exceed tolerances explained above and if they cannot easily be explained, but is left to the discretion of the FSTD operator and the NAA.

Attachment I

GUIDANCE ON DESIGN AND QUALIFICATION OF NON TYPE-SPECIFIC FSTDs

1. BACKGROUND

Unlike type-specific FSTDs, non type-specific FSTDs are intended to be representative of a group of helicopters. In other industry documents, the expression “generic device” has normally been used to designate such non type-specific devices. However, in this attachment, the expression “generic device” has been replaced by “non type-specific” to preclude confusion with the fidelity level “G”. It further reduces the implication that these devices are exclusively linked to “G” simulation feature fidelity levels as they could include “R” or even “S” fidelity levels of another aircraft type than the main one of interest for the training programme. The guidance given in this attachment is primarily applicable to the baseline ICAO Type I and II device categories, as defined in Chapter 2, Table 2-1 of this Part, as well as to any other non type-specific devices utilizing G or R fidelity levels in the following helicopter-related simulation features: Cockpit Layout and Structure, Flight Model (Aero and Engine), Ground Handling, Helicopter Systems (ATA), and Flight Controls and Forces.

2. DESIGN STANDARDS

2.1 *Simulated helicopter configuration*. The configuration chosen should be that of the group of helicopters likely to be used in the training programme. It would be in the interest of all parties to engage in early discussions with the NAA to agree on a suitable configuration, the so called “*designated helicopter configuration*.” Ideally, any such discussion would take place in time to avoid any delays in the design/build/acceptance/qualification process thereby ensuring a smooth entry into service.

2.2 *Cockpit*. The cockpit should represent the designated helicopter configuration. To ensure a good training environment, the cockpit should be sufficiently enclosed to minimize any distractions. The controls, instruments and avionics controllers should represent the touch, feel, layout, colour and lighting of the designated helicopter configuration, to create a positive learning environment and to allow for a good transfer of training to the helicopter.

2.3 *Cockpit components*. As with any training device, the components used within the cockpit area do not need to be aircraft parts. However, any parts used should represent the typical training helicopters and should be robust enough to endure the training tasks. With the current state of technology, the use of simple representations based on flat display technology and touch screen controls to represent objects other than basic push-button types of controls would not be acceptable. The training tasks envisaged for these devices are such that appropriate layout and feel is very important. For example, the altimeter sub-scale knob needs to be physically located on the altimeter. The use of flat display technologies with physical overlays incorporating operational switches/knobs/buttons replicating a helicopter instrument panel may be acceptable.

2.4 *Data package*.

2.4.1 The data for the aerodynamics model, flight controls and engines should be soundly based on the “designated helicopter configuration.” It is not acceptable and would not support good training if the models merely represented a few key configurations bearing in mind the extent of the credits available.

2.4.2 Validation data may be derived from a specific helicopter within the group of helicopters that the FSTD is intended to represent, or it may be based on information from several helicopters within that group, reflecting the "designated helicopter configuration." It is recommended that the intended validation data together with an engineering report be submitted to the NAA for evaluation and approval prior to the commencement of the manufacturing process.

2.4.3 For validation tests with G fidelity requirements, where the required tolerances are CT&M, validation data are not required. Rather, subjective testing of the FSTD will be used to produce a baseline ("footprint") objective test result, against which the recurrent test result will be compared during recurrent evaluations. In this case, an engineering report should be provided. This report may include flight test data, manufacturer's design data, information from the rotorcraft flight manual and maintenance manuals, results of approved or commonly accepted simulations or predictive models, recognized theoretical results, information from the public domain, or other sources as deemed necessary by the FSTD manufacturer to substantiate the proposed model.

2.4.4 *Data collection and model development*. A basic requirement for any modelling is the integrity of the mathematical equations and models used to represent the flying qualities and performance of the designated helicopter configuration being simulated. The models should be continuous and demonstrate the correct trend and magnitude throughout the required training flight envelope. Additional data to refine the non-type-specific model can be obtained from many sources, such as helicopter design data, flight and maintenance manuals, observations on the ground and in the air, etc., without necessarily having to conduct dedicated flight testing. Data obtained on the ground and in flight can be measured and recorded using a range of simple means such as video cameras, paper and pencil, stopwatch, or new technologies (e.g. GPS).

2.4.5 Any such data gathering should take place at representative masses and centres of gravity. Development of such a data package including justification and the rationale for the design and intended performance, the measurement methods and recorded parameters (e.g. mass, CG, atmospheric conditions) should be carefully documented and available for inspection by the NAA as part of the qualification process.

2.5 *Flight controls*. An active force feedback cueing system in which forces vary not only with position but with configuration (speed, trim), if appropriate for the designated helicopter configuration, may be necessary for the representative "R" fidelity level of the flight controls and forces simulation feature. For the generic "G" fidelity levels of the same simulation feature, a passive force cueing system utilizing springs would be acceptable. But it should be remembered that it is vitally important to prevent negative learning and that negative characteristics would not be acceptable.

3. TESTING AND EVALUATION

3.1 The validation tests specified in Appendix B to this Part may be flown by a suitably skilled person and the results recorded manually. However the use of automatic recording and testing is encouraged, thereby increasing the repeatability of the achieved results.

3.2 The tolerances specified are designed to ensure that the device meets its original target criteria year after year. It is therefore important that such target data are carefully derived and values are agreed with the appropriate NAA in advance of any formal qualification process. For initial qualification, it is highly desirable that the device should meet its design criteria within the listed tolerances. However, unlike the tolerances stipulated for type-specific devices, the tolerances stated for non type-specific FSTDs are purposely intended to be used to ensure repeatability during the life of the FSTD and in particular at each recurrent evaluation.

3.3 The subjective tests listed in Appendix C to this Part should be flown out by a suitably qualified and experienced pilot.

Attachment J

APPLICABILITY OF NATIONAL AVIATION AUTHORITY REGULATION AMENDMENTS TO FSTD DATA PACKAGES FOR EXISTING HELICOPTERS

1. GENERAL POLICY

1.1 Except where specifically indicated otherwise within the Table of FSTD validation tests in Appendix B to this Part, validation data for QTG objective tests are expected to be derived from helicopter flight tests (see Attachment I to this Part, *Guidance on design and qualification of non type-specific FSTDs*, for other exceptions).

1.2 Ideally, data packages for all new FSTDs will fully comply with the current standards for qualifying FSTDs.

1.3 For types of helicopters first entering into service after the publication of a new revision of the NAA regulations, the provision of acceptable data to support the FSTD qualification process is a matter of planning and regulatory agreement (see Attachment A to this Part, *FSTD Qualification for New Helicopter Types*).

1.4 For helicopters type-certificated prior to the applicability of a new amendment of NAA regulations, it may not always be possible to provide the required data for any revised or additional objective test cases compared to the previous amendments of the regulations. After prototype certification, manufacturers do not normally keep flight test helicopters available with the required instrumentation to gather additional data. In the case of flight test data gathered by independent data providers, it is most unlikely that the test helicopter will still be available.

1.5 Notwithstanding the above, the preferred source of validation data is flight test, though other types of data are acceptable (see, for example, Attachment B to this Part, *Engineering simulation validation data*). It is expected that best endeavours will be made by data suppliers to provide the required flight test data. If any flight test data exist that address the requirement (collected during the certification or any other flight test campaign), such test data should be provided. If any possibility exists to obtain these flight test data on the occasion of a new flight test campaign, this should be done and provided in the data package at the next issue. Where flight test data are genuinely not available, alternative sources of data may be acceptable using the following hierarchy of preferences:

a) flight test at an alternate but near equivalent condition/configuration substantiated by one or more rationale(s) to explain the choice;

b) for certain multi-engine helicopters with safety restrictions and/or damage considerations regarding performing actual OEI flight manoeuvres, flight test data gathered using an OEI training mode for certain required OEI test cases (see 1.7 below);

c) data from an audited engineering simulation from an acceptable source (for example, meeting the guidelines laid out in Attachment B to this Part, *Engineering simulation validation data*), or as used for aircraft certification;

d) helicopter performance data published by the aircraft manufacturer in documents such as the rotorcraft flight manual, operations manual, performance engineering manual or equivalent, or other approved published sources (e.g. production flight test schedule);

e) Where no other data are available, then unpublished but acceptable sources (e.g. calculations, simulations) may be used, subject to a case-by-case review with the NAA concerned, taking into consideration the level of qualification sought for the FSTD; and

f) Only when a) to e) above cannot be met, then pilot subjective assessment may be used to create a baseline, and recorded as footprint test(s) from the actual FSTD undergoing qualification.

1.6 In certain cases, it may make good engineering sense to provide more than one test to support a particular objective test requirement. An example might be an OEI take-off test, where the flight test engine and power profile do not match the simulated engine. The OEI take-off test could be run once with the flight test power profile as an input and another time with a fully integrated response to a fuel cut on the simulated engine.

1.7 Modern multi-engine helicopters are increasingly being fitted with OEI training modes to provide a simulation in flight of operating with one engine not apparently delivering any power/torque to the rotor system. The flight manuals of such helicopters will typically prohibit the actual cutting, or even reduction to idle, of one engine whilst in flight. Consequently the capture of the data required to simulate or validate a genuine engine failure will be extremely difficult to obtain, or in effect non-existent. Data will then be captured during actual helicopter flight tests using the OEI training mode. However, it is reasonable to propose that an integrated simulation that demonstrates a good match to all other flight test results ought to predict an acceptable simulation of a sudden engine failure. For these simulators a comparison, preferably by overplot, should be made between the response to the selection of the OEI training mode in the helicopter and the simulator response to an engine failure triggered from the IOS, or to a sudden reduction to idle. If the comparison reveals significant differences sufficient to query the training effectiveness of OEI operation, a thorough rationale will be required. Due to the complex nature of automatic engine control in an OEI condition, any proposal to validate helicopter OEI performance through the use of validation data collected in an OEI training mode will require coordination with the NAA well in advance of the FSTD evaluation.

1.8 For helicopters type-certificated prior to the date of applicability of an amendment to the NAA regulations, an operator may, after reasonable attempts have failed to obtain suitable flight test data, indicate in the MQTG where flight test data are unavailable or unsuitable for a specific test. For each case, where the preferred data are not available, a rationale should be provided laying out the reasons for the non-compliance and justifying the alternate data/test(s) used.

1.9 These rationales should be clearly recorded within the validation data roadmap in accordance with and as defined in Attachment D to this Part.

1.10 It should be recognized that there may come a time when there is so little compatible flight test data available that the gathering of new flight test data may be required.

2. RECOMMENDATION FOR THE USE OF FOOTPRINT TESTS

2.1 Only when other practical alternative sources of data have been thoroughly investigated without success, may a footprint test be acceptable (see Attachment I to this Part, *Guidance on design and qualification of non-type-specific FSTDs*, for exceptions), subject to a case-by-case review with the NAA concerned taking into consideration the level of qualification sought for the FSTD.

2.2 Footprint test data should be:

a) constructed with initial conditions and the simulator being set up in the configuration required for the required data (e.g. correct engine power rating);

b) a manoeuvre representative of the particular helicopter being simulated;

c) based on a footprint test manoeuvre manually flown out by a type-rated pilot (see note below) who is current on type and approved by the NAA;

d) constructed from validation data obtained from the footprint test manoeuvre and transformed into an automatic test;

e) used in an automatic test run as a fully integrated test with pilot input controls;

f) automatically run for the initial qualification and recurrent evaluation; and

g) supplemented, whenever possible, with flight test data which will further substantiate the intended purpose and key aspects of the test being presented.

Note.— The pilot flying the manoeuvre should sign off the complete test as being fully representative.

2.3 A clear rationale should be included in the QTG for each footprint test. These rationales should be added to and clearly recorded within the validation data roadmap in accordance with and as defined in Attachment D to this Part.

2.4 Where the number of footprint tests is deemed by the NAA to be excessive, the FSTD level of qualification may be affected. The NAA should review each area of validation test data that proposes the use of footprint tests as the basis for the validation data. Consideration should be given to the extent to which footprint tests are used in any given area. For example, it would be unacceptable if all or the vast majority of hover tests were proposed as footprint tests, with little or no flight test data being presented. It should be recognized, therefore, that it may be necessary for new flight test data to be gathered if the use of footprint tests becomes excessive, not just overall, but also in specific areas.

2.5 For recurrent evaluation purposes a close match is to be expected (refer to Attachment H to this Part, *Recurrent evaluations — Presentation of validation test data*). Validation tests using footprint data, which do not meet the test criteria, should be addressed to the satisfaction of the NAA.

2.6 The NAA should be consulted well in advance of the QTG submission if footprint tests are to be used.

Attachment K

GUIDANCE FOR THE QUALIFICATION OF AN FSTD HEAD-UP DISPLAY (HUD)

1. APPLICABILITY

1.1 This procedure applies to all FSTDs with a head-up display (HUD) installation.

1.2 For the purpose of this document, "HUD" will be used as a generic term for any alternative helicopter instrument system which displays information to a pilot through a combiner fixed to the helicopter airframe in the normal "out of the window" view.

1.3 This attachment details one means to evaluate and qualify an FSTD HUD system. If an operator desires to use another means, a proposal should be submitted to the NAA for review and approval.

1.4 Qualification test guides (QTGs) for new, updated or upgraded FSTDs incorporating a HUD system should contain a HUD statement of compliance. This statement should be an attestation that HUD hardware and software, including associated displays, function the same as that installed in the helicopter. A block diagram describing the input and output signal flow and comparing it to the helicopter configuration should support this statement.

1.5 Additional and more general information is given in Attachment L to this Part, *Guidance for the qualification of an FSTD enhanced flight vision system (EFVS)*, which describes a more generic approach for the integration and qualification of enhanced flight vision systems, including HUD systems which exceed the classical HUD functionality (display of values and symbology only).

2. FSTD/HUD STANDARDS

2.1 Whether the HUD system is an actual helicopter system, or is software simulated, the system should be shown to perform its intended function for each operation and phase of flight.

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

3. OBJECTIVE TESTING

3.1 Static calibration tests should be included for HUD attitude alignment in the QTG. These tests may be combined with the alignment tests for the FSTD visual system. Refer to Appendix B to this Part for additional information.

3.2 HUD systems that are software simulated (not being an actual helicopter system) should include latency/throughput tests in all three axes. The HUD system display should be within 100 ms of the control input.

4. SUBJECTIVE TESTING

4.1 The NAA evaluator should evaluate accurate replication of HUD functions.

4.2 The ground and flight tests that should be conducted for the qualification of HUD systems are listed below and may be combined with subjective manoeuvres not dedicated to HUD testing. Only those phases of flight for which the particular HUD system is authorized should be tested. The evaluation should be conducted using daylight, dusk, and night conditions.

1) Pre-flight:
   a) Pre-flight inspection of the HUD system.
2) Taxi:
   a) HUD taxi guidance.
   b) Combiner horizon matches the visual horizon within the manufacturer's tolerance.
3) Take-off:
   a) Normal take-off in visual meteorological conditions.
      1) Centre line guidance if available.
   b) Instrument take-off using the lowest RVR authorized for the particular HUD.
   c) Engine-out take-off.
   d) Maximum demonstrated crosswind take-off.
   e) Wind shear during take-off.
4) In-flight:
   a) Climb.
   b) Turns.
   c) Cruise.
   d) Descent.
5) Approaches:
   a) Normal approach in visual meteorological conditions.
   b) ILS approach with a crosswind:
      1) Flight path vector should represent the inertial path of the aircraft;
      2) Course indication matches the track over the ground; and
      3) HUD combiner should not excessively degrade the approach lights.

c) Engine-out approach and landing.

d) Non-precision approach.

e) Circling approach, if applicable.

f) Missed approach – normal and engine-out.

g) Maximum demonstrated crosswind approach and landing.

h) Wind shear on approach.

6) Malfunctions:

a) Malfunctions causing abnormal pre-flight tests.

b) Malfunctions logically associated with training during take-off and approach.

c) Malfunctions associated with any approved flight manual abnormal procedures which are not included above.

4.3 Some HUD systems have been certified without emergency power backup. Therefore, they will blank out and effectively reboot if any temporary power loss occurs. This should be confirmed by checking the manufacturer's data.

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Attachment L

GUIDANCE FOR THE QUALIFICATION OF AN FSTD ENHANCED FLIGHT VISION SYSTEM (EFVS)

1. BACKGROUND

1.1 The growing use of Enhanced Flight Vision Systems (EFVS) in helicopter operations has led to an increase in the requirement for the associated training to be conducted in FSTDs, especially as an introduction to these devices in a synthetic device can be achieved in complete safety. The multitude of available systems such as radar, Thermal Imaging (TI) and image intensification Night Vision Goggle (NVG) systems (which can provide guidance to the flight crew by means of symbolic cues, laser-based information, artificial and real images) make it complex to address specific requirements for individual systems. However, EFVSs are classified below and their inclusion within FSTDs is discussed.

1.2 This attachment provides guidance for the design and integration of EFVSs in a helicopter FSTD and addresses the affected simulation features.

1.3 Additional guidance is available from the following documents:

- FAA AFS-205 10-01 (*Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices*)
- FAA AFS-205 03-02 (*Head-Up Display (HUD) Simulator Qualification*)
- FAA AFS-205 03-03 (*Enhanced Flight Vision System (EFVS) FSTD Qualification*)
- JAA Temporary Guidance Leaflet 12 (*Guidance for Enhanced Vision System (EVS) Simulator Qualification*)
- New Zealand Civil Aviation Authority AC91-13 (*Night Vision Imaging Systems — Helicopter*).

2. CLASSIFICATION OF EFVS EQUIPMENT

2.1 *Overview*

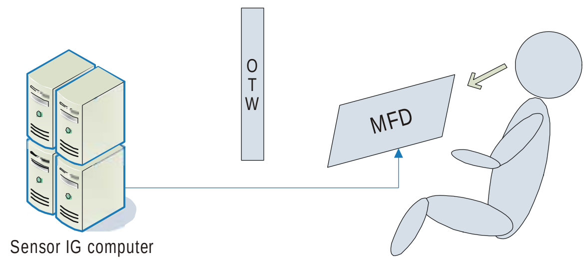
Due to the variety of available device technologies it is reasonable to classify discrete device types according to affected simulation features. One can categorize these devices or systems independently from the EFVS technology used in the real helicopter system and, instead, classify them according to how artificially generated images are produced. Distinction is also made between images provided to the crew, either by means of devices the trainee looks at (e.g. Multi-Function Display (MFD)) or by devices the trainee looks through onto the OTW projection, e.g. HUD or HMD.

2.2 *Classification*

This classification results in three discrete device types, for which dedicated requirements for implementation can be derived:

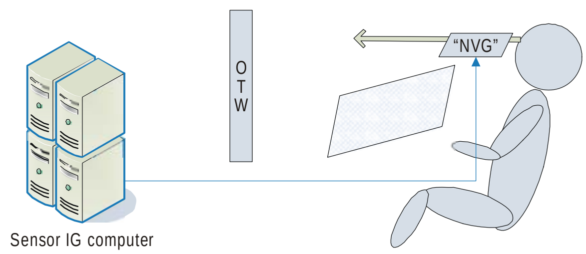
Type 1. EFVS simulated on cockpit displays the trainee looks at, utilizing artificially generated images.

Example: Thermal image provided by a sensor Image Generator (IG) and displayed on an MFD.



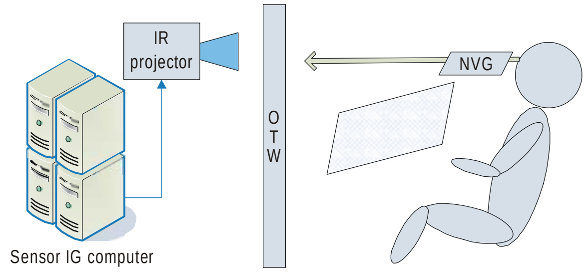
Type 2. EFVS simulated on "see through" displays such as an HMD or HUD, utilizing artificially generated images.

Examples: Thermal image displayed on an HMD; brownout/whiteout landing system providing visual aids to the pilot in an HMD; an artificially generated NVG image displayed in simulated NVG.



Type 3. Stimulated EFVS utilizing real equipment and driven by a physical stimulus.

Example: Stimulated NVG using real equipment and an infrared projection.



Note.— Currently, only NVGs are classified as Type 3 devices.

3. AFFECTED SIMULATION CHARACTERISTICS

3.1 Depending on the type of EFVS device, specific simulation characteristics are affected and need to meet certain requirements to provide acceptable visual cues.

3.2 When a Type 1 EFVS is used, the following simulation characteristics are affected:

- *EFVS IG/OTW database synchronization.*
  Design and integration of the EFVS system should ensure that the correlated displays are coherent with the sensor orientation, the OTW scene content, and relevant instrument/cueing indications.

3.3 When a Type 2 EFVS is used, the following simulation characteristics are affected:

- *Sensor IG/OTW database synchronization.*
  Design and integration of the EFVS system should ensure that the correlated displays are coherent with the sensor orientation, the OTW scene content, and relevant instrument/cueing indications.

- *EFVS display device.*
  Bore sight alignment, orientation, collimation and focus of the EFVS display device should deliver coherent content in the EFVS display.

- *Cockpit.*
  Cockpit illumination should support the training use of the EFVS system by providing the appropriate levels of lighting whenever the EFVS system is used.

3.4 When a Type 3 EFVS is used, the following simulation characteristics are affected:

- *OTW database synchronization.*
  Design and integration of the EFVS system should ensure that the OTW scene stimulates the devices and also displays appropriate, night visual scene content.

- *EFVS display device.*
  Bore sight alignment, collimation and focus of the EFVS display device should deliver coherent content in the EFVS display and symbolic cues should reflect coherent instrument indications.

- *The OTW scene.*
  - For FSTDs using a specific (S) cockpit:
    The type of display device must be identical to that referenced in the Supplemental Type Certificate (STC) for the specific helicopter being simulated, in accordance with the NAA's regulations.

  - For FSTDs using a representative (R) cockpit:
    The type of display device must be representative of the type utilized in the training task conducted in the real helicopter. This includes the configuration (monocular, binocular, HUD, visor, etc.) as well as the spectral stimulation and the spectral response.

  - For FSTDs using a generic (G) cockpit:
    Any type of display device may be used as long it supports the training to be conducted.

- *Projection system.*
  The projection system should provide the correct stimulus to the original EFVS equipment including, but not limited to, the spectral range of stimulation, intensity of stimulation and typical effects causing a training relevant reaction (e.g. image blooming) in the stimulated EFVS system. The projection system must not only stimulate the EFVS but also provide visual spectrum night scene content.

- *Cockpit*.
  Window transparency and cockpit illumination should be compatible with the EFVS system.

4. GUIDELINE ON IMPACT ON SIMULATION CHARACTERISTICS

4.1 *Statement of compliance*

4.1.1 For those FSTDs where EFVS hardware is not provided as original equipment and is subsequently added to the simulator, a statement of compliance is required. This must state that the simulation of the added EFVS hardware/software, including associated cockpit displays and indications, replicates the original EFVS installed in the helicopter.

4.1.2 A block diagram describing the input/output signals and comparing it to the helicopter EFVS functionality and configuration should support this statement.

4.2 *Sensor IG/OTW database synchronization (applicable for all EFVS types)*

- Visual ground segment.
  Since the sensor position is often remote from the pilot's eyepoint position, tests for the visual ground segment (see Appendix A to this Part, 7.12) should be repeated with each replicated sensor being simulated with special regard to the actual sensor position on the helicopter.

- EFVS – OTW – Cockpit indication coherence.
  A subjective test ensuring the coherence of the EFVS display content, OTW display and instrument indications should be performed. The test should include all information being displayed in the EFVS display (artificial image, data, and symbology) and the correlation checked with all corresponding cockpit indications and instruments.

- The following examples should give an idea of the type of test being performed:
  - For an imaging sensor the coherence with the OTW should be checked as well as the correlation of objects displayed in the EFVS to their representation on other displays (e.g. digital map) if applicable.
  - For an EFVS system displaying calculated attitude data (e.g. HMD in brownout situations) the EFVS indication should be checked against the helicopter's normal attitude indications (e.g. on primary flight display and backup instruments) and other sensor and OTW displays in this situation.

4.3 *Instructor Operating Station (IOS) (applicable for all EFVS types)*

The IOS should include an EFVS display repeater of the EFVS being simulated, as seen through the pilot's HUD, HMD or on the cockpit displays. This includes any displayed data and symbology. The display format (aspect ratio) should be replicated.

4.4 *Type 2 EFVS display device*

4.4.1 A Type 2 device display should be adjustable (as per the real helicopter) and tunable to match the brightness of the EFVS display relative to the cockpit lighting and OTW brightness in the original helicopter.

4.4.2 A Type 2 display device should be properly bore sighted and aligned to the FSTD platform or pilot eye position as in the real helicopter. There should be proper alignment of the visual databases used for the OTW image generation and the database used for the sensor image generation.

- *HUD alignment*
  The HUD alignment should be ensured via a static calibration test (*refer to paragraph 1.3 of the FAA's Flight Standards Service, National Simulator Program AFS-205 03-02*). A pattern consisting of points and/or scales should be projected in the OTW view and the HUD device. The pattern should be generated by the corresponding image generators and should cover at least the field of view covered by the HUD device from the pilot's eyepoint position.

  In non-collimated displays it has to be ensured that the collimation distance of the HUD device matches the distance to the projection surface. In collimated displays the collimation distance of the HUD device should match the distance of the OTW projection to the pilot's design eyepoint.

- *HMD alignment*
  Usually in a system providing an HMD, the pilot's head position needs to be tracked in order to compensate for errors between aircraft electronic line of sight and individual pilot's visual line of sight and to provide orientation commands to the remote sensor. This methodology permits computation of the sensor image and symbology, if applicable, depending on the pilot's line of sight and the absolute position of the head relative to the design eyepoint position. The head tracker as well as the projection system geometry cause additional angular errors concerning the image alignment between the HMD and OTW image. These errors are not static, but depend of the pilot's line of sight and the absolute position of the pilot's head inside the area where the head tracker is able to detect the head position ("head motion box").

  For these reasons, and especially if the EFVS provides OTW related images or symbols, an HMD dynamic test should be performed, taking measurements at the pilot's head position when looking forward along the helicopter's longitudinal axis, and also at the maximum angular positions left/right and up/down (head turned), in the centre as well as at the borders of the head motion box (head moved).

  A pattern consisting of points and/or scales should be projected in OTW and the HMD device. The pattern should be generated by the corresponding image generators and should cover at least the field of view covered by the HMD device from the pilot's eyepoint position when the head of the pilot is turned in its maximum angular positions.

  In non-collimated displays it has to be ensured that the collimation distance of the HMD device matches the distance to the projection surface. In collimated displays the collimation distance of the HMD device should match the distance of the OTW projection to the pilot's design eyepoint.

- *Delay*
  The image or symbology generated by the sensor IG and displayed in the EFVS device should not be delayed by more than 30 ms after the OTW visual system (*refer to paragraph 1.3, AFS 205 03-03, Objective tests*).

4.5 *Type 2 cockpit illumination*

4.5.1 For a Type 2 device the trainee looks at two different, artificially generated images. The OTW image should be tuned according to the requirements given in Appendix A to Parts II or III, 7.5 (light-point contrast ratio) and 7.6 (system brightness).

4.5.2 The cockpit illumination should be variable and tuneable to a level that is not distracting to the crew in lighting situations when the EFVS is used. This applies to the cockpit panel illumination ("simulated lighting") as well as to each kind of supplemental lighting provided in the FSTD cockpit, e.g. the ambient lighting.

4.6 *Type 3 EFVS cockpit*

4.6.1 The EFVS Type 3 cockpit is required to be NVG compatible since the original equipment is used in the FSTD (Type 3 EFVS devices are currently limited to NVG).

4.6.2 The OTW projection for daylight scenes normally does not replicate the lighting levels of the real world and is less bright. The cockpit lighting is normally adapted to the simulation level of lighting and therefore is also less bright than in a natural environment.

4.6.3 For use of stimulated NVG equipment the non-daylight lighting levels should replicate the natural environment lighting conditions without any adaption to simulation conditions since real equipment NVG devices require an identical level of stimulation as in the real world.

4.6.4 The cockpit windows should provide a transparency as close as possible to the original cockpit windows, including effects of coating, in the visible and infrared parts of the image. Effects present in the real helicopter such as reflections resulting from interior lighting, should be replicated when they affect the training delivery.

4.6.5 Generally, two methodologies of proving the NVG compatibility of an FSTD cockpit are possible:

- There is a broad variety of methods existing for the test of the NVG compatibility of an aircraft/helicopter cockpit (e.g. RTCA/DO-275 – *Minimum Operational Performance Standards for Integrated Night Vision Imaging System Equipment*, 12 October 2001; ASC/ENFC 96-01 REV 1 – Interface document, *Lighting, Aircraft, Interior, Night Vision Imaging System (NVIS) Compatible*, 22 March 1996; MIL STD-3009 – *Dept of Defense, Interface Standard for Lighting, Aircraft, Night Vision Imaging System (NVIS) Compatible*, 2 February 2001), all featuring the basic concept that no light source in the adapted cockpit should appear brighter than a reference chart (USAF 1951 tri-bar resolution chart) illuminated with an NVIS radiance[1] of 1.7×10^{-10} W/cm²-sr for a NVIS-A or 1.6×10^{-10} W/cm²-sr for a NVIS-B compatible cockpit, which equals approximately the intensity of clear star light. The chart is positioned at a distance in front of the cockpit suitable to resolve the resolution of the pattern printed on the chart. When turning off and on the cockpit illumination no degradation in the resolution seen on the target should appear.

  The same principle can be used in the FSTD environment. The USAF 1951 tri-bar resolution chart or an area of comparable brightness, containing a resolvable resolution pattern, can be projected in front of the cockpit. The brightness of this area can be verified with standard luminance measurement equipment in order to match the lighting intensity as in clear starlight lighting conditions. The principle of checking the compatibility could be the same as in the real helicopter.

1. The terms NVIS radiance, NVIS-A and NVIS-B are explained on the first page of the document "Night Vision Imaging System Lighting Compatibility Assessment Methodology" available at: http://www.hf.faa.gov/docs/508/docs/VF%20-%20NVG%20Pinkus.pdf.

- From this test methodology the spectral requirements on the instrument illumination in MIL-STD-3009 have been derived. These values can be used directly for the verification of the simulation panel brightness by measuring the devices directly inside the simulation cockpit. The spectral emission and lighting intensity of each cockpit control panel should match the requirements given in the standard. Nevertheless a test with the NVG device being used in the simulation should be performed in order to detect additional light sources not present in the real helicopter (e.g. test lights on simulator equipment or components).

4.7 *Cockpit environment/Dome for Type 3 EFVS*

The environment — all supplementary lights, emergency lightings, etc. –is required not to distract the NVG training. Consequently the environment lighting should be at least NVG friendly with the possibility to switch it off for the training procedures.

4.8 *Type 3 projection system*

- *Overview*

  The eye of the trainee is stimulated by the OTW RGB projection, providing the OTW image in the normal spectral range the human eye is sensitive in (about 350 nm to 700 nm), called the visual or RGB image part later on. The NVG device is stimulated mainly by the radiation in the near infrared (about 625/665 nm to 900/1 100 nm, depending on the NVG lens coating and NVG device being used). Both parts of the images, the RGB and the infrared part, should be coincident on the projection screen.

  Since this section deals with the RGB and the infrared part of an image, this does not imply the usage of two different projectors or two independent images. Some systems utilize the RGB image by applying IR filtering, hence only one image is used. For these systems, the sections dealing with the IR image apply accordingly to the IR part of the RGB image projected.

  Lighting in the natural environment is detectable at long range with NVG and this facet is also required in a synthetic environment; similarly, any images used to stimulate NVG should also be visible to the unaided eye in the FSTD environment and a projection of near IR energy alone is insufficient to replicate a night visual scene.

- *Alignment*

  This section is applicable only if two images are used for the NVG OTW projection. Due to the requirement to superimpose images on the projection surface, an alignment error between these images could become a key point for a proper image perception when the image is generated by two different projectors. Especially in low light conditions with night-adapted eyes, the trainee is required to see both images – the NVG or infrared image part in his NVG device and the RGB image part in his peripheral view (or direct view if the NVG are raised/removed). Even though the perception of the OTW image is usually limited to outlines, lights should be visible in the visual spectrum and scene content may need to be more discernible when flying in areas containing high levels of cultural illumination (from street lamps or city lights) or in periods of high moonlight. During certain manoeuvres, especially during take-off and landing and in confined area operations, coincident visible and near IR images are essential.

- *Independence of the image*

  The OTW RGB image part and the infrared image part should be tuneable independently from each other in order to allow a realistic adaption of the RGB OTW brightness levels to the NVG brightness levels in situations where both images are visible to the crew (OTW RGB image part with the eye, infrared image part using the NVG device).

  It should be ensured that the visible and the infrared part of the image are not disturbing or influencing each other. This applies especially to the degeneration of the RGB image concerning the red or reddish colours in lighting conditions in which both parts of the image are visible (e.g. dusk or dawn).

- *Spectral and contrast requirements*

  When a real NVG device is stimulated in the FSTD, all device-related effects such as noise and halos should be stimulated since they are inherent to the device. This is the rationale for the following requirements on contrast and brightness.

  The OTW RGB image should simulate correctly the visibility conditions in dusk, dawn and night conditions and should support the stimulation of typical NVG effects at low lighting intensities. The overall projection brightness should be tuneable down to a level which produces sufficient signal to noise ratio for the intended training.

  In normal lighting conditions the contrast of the OTW RGB image should be in accordance with the requirements given in Appendix A to Parts II or III, 7.5 (light-point contrast ratio) and 7.6 (system brightness). These requirements should not be affected or confined by the infrared part of the image.

  The combined contrast and brightness of the RGB and infrared parts of the OTW image should be sufficient to stimulate the effects typical for NVG such as noise, halos, dazzle and glare. These effects are stimulated by providing the correct intensities in the RGB and infrared parts of the image. Noise of the NVG device is stimulated by a low lighting intensity in the sensitive spectral range of the NVG device. Saturation effects on the other hand are stimulated by a corresponding high intensity of the projection (visual and infrared spectrum lighting causes blooming and even shutdown of NVG devices).

  Therefore the infrared part of the image should at least provide lighting conditions as in illumination conditions down to a level such that the NVG device selected for training produces an image noise level comparable to the level of noise the device would produce in the real world in night conditions, clear sky and without moon illumination (new moon). Since the spectral responsiveness of an NVG device is much higher in the infrared spectral range this value must be lower than in the RGB part of the image.

  In order to stimulate saturation effects (e.g. halos) the light-point intensity should be sufficient for stimulation of halos and complete saturation effects of the NVG device used in training.

- *Simulated effects*

  Effects which are inherent to the NVG device such as noise, halos, dazzle and glare are produced by the device itself and do not need to be simulated by the IR IG, but the combined RGB/infrared images must be capable of stimulating these effects by projecting the correct intensities and contrast ratios (refer to 4.8 d)).

The combined RGB and infrared simulation should comprise effects typical for NVG such as:

- weather: fog, aerosol, rain, snow, hail and clouds (including transparency effects with NVG seeing through mist and shallow cloud);
- moon: light, shadows, intensity for halo effects;
- artificial lights (obstacle lights, runway lighting, city lights, etc.);
- any type of visible lighting of the helicopter being simulated, such as search light, IR search light, position lights, strobes, etc.);
- warm and hot objects;
- vegetation, bright chlorophyll; and
- engine exhaust.

4.9 *Proposed acceptance procedure*

4.9.1 The proposed ground and flight tests are listed below. Tests should ensure that the EFVS performs appropriately for pilot training and checking as specified in the approved training programme. The evaluation should be conducted using daylight, dusk, and night conditions.

4.9.2 Pre-flight:

a) pre-flight inspection of the EFVS system; and

b) start-up procedures, check of start-up timing, cooling times, if applicable, initialization sequences, etc.

4.9.3 Taxi:

a) evaluation of EFVS taxi guidance, if applicable; and

b) if additional symbology or information is provided by the EFVS, check that the guidance symbology (e.g. displayed horizon) matches the corresponding visual representation (e.g. visual horizon) within the manufacturer’s tolerance, if any; check that any other information displayed in the EFVS display is coherent with the corresponding cockpit indication.

4.9.4 Take-off:

a) normal take-off in VMC:

for imaging systems check the consistency with the OTW representation; if additional symbology or information is provided by the EFVS, check that the symbology (e.g. displayed horizon) matches the corresponding visual representation (e.g. visual and artificial horizon) within the manufacturer’s tolerance, if any; check that any other information displayed in the EFVS display is coherent with corresponding cockpit indications;

b) instrument take-off using the lowest visibility authorized for the particular EFVS under test. Test should take into account any special condition the EFVS is designed for (e.g. whiteout/brownout situation, thermal crossover for thermal imaging sensors, flying with zero visibility);

c) wind shear during take-off; and

d) engine out take-off.

Note.— Some EFVS systems have been certificated without emergency power backup. Therefore, they will blank out and effectively reboot if any temporary power loss occurs. This should be confirmed by checking the manufacturers' data.

4.9.5 In-flight:

a) for imaging systems, check consistency with the OTW representation – a daylight scene in VMC conditions is recommended for this test;

b) if additional symbology or information is provided by the EFVS, check that the symbology (e.g. displayed horizon) matches the corresponding visual representation (e.g. visual or PFD horizon) within the manufacturer's tolerance, if any; check that any other information displayed in the EFVS display is coherent with the corresponding cockpit indications;

c) check all available operating modes: the observed behaviour should be representative of the original equipment;

d) execute turns to verify the correct correlation with all other cockpit instruments (e.g. PFD);

e) execute climbs, descents, accelerations and decelerations to confirm proper display of trend indicators and acceleration vectors, if any;

f) verify that the EFVS display responds to control inputs and guidance panel selections (e.g. V/S (vertical speed mode), IAS), if applicable;

g) intercept and track a navigation course, check navigation indications, if any; and

h) manoeuvre the aircraft through sufficient pitch and roll excursions to check format changes and horizon locator indicators or "attitude chevrons."

4.9.6 Approaches:

a) normal approach in VMC;

b) ILS approach with and without crosswind (in VMC). Check to see that the flight path indications on the EFVS display represent the inertial path of the aircraft, if applicable;

c) engine out approach and landing;

d) special situation approaches that the EFVS is designed for, e.g. whiteout/brownout situation, landing in zero visibility conditions, detection of obstacles in confined area landing sites; and

e) non-precision approach.

4.9.7 Malfunctions:

a) malfunctions causing abnormal pre-flight tests;

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

c) malfunctions concerning EFVS input parameters, e.g. camera failure, sensor failure, invalid inputs, causing the EFVS to behave abnormally; and

d) malfunctions associated with any Rotorcraft Flight Manual procedures that are not included above.

Attachment M

GUIDANCE FOR THE EVALUATION OF A FLIGHT PROCEDURES TRAINING DEVICE (FPTD)

1. INTRODUCTION

1.1 Operators have used flight procedures training devices (FPTD), previously referred to as part task trainers, for many years as an integral part of their training programme. This attachment provides guidance on the evaluation of such devices and may be useful in assessing the device acceptability for use in an operator's approved training programme.

1.2 Some FPTDs have been used to acquire flight time training credits, while others have not. Those that provide flight time training credits have been qualified by the NAA. Within the context of this attachment, a flight time training credit is accredited time used to reduce required flight training time in the helicopter or in a higher level FSTD. An operator considering an FPTD qualification should refer to Parts I and III and consult its NAA. This attachment may provide useful guidance in the qualification requirements for such a device.

2. REQUIREMENTS

2.1 An FPTD is a helicopter type-specific device to be used to train for explicit tasks. It does not have to fly nor to have flight controls. It should have at least one system simulated. This device can range in complexity from very simple to very sophisticated, i.e. from a simple FMS control and display unit programming unit to a full size cockpit that replicates all auto-flight functions of the helicopter. Flat panel trainers have significant utility in an operator's ground school programme and, particularly with some associated hardware, may also be useful as an FPTD within the operator's approved training programme.

2.2 Table M-1 contains the minimum requirements for such a device. The first column in the table provides the requirement number from the table in Appendix A to this Part. There are no validation test requirements. The device is meant to be evaluated through the applicable tests of Appendix C to Part III.

2.3 Table M-2 is a suggested method of recording the training and possible checking capability when using the device. The table is generic and meant to cover most helicopter types and systems. The operator is encouraged to modify the table to meet its needs by adding new events and/or deleting extraneous items. The recommended use of Table M-2 is for the operator to record all the intended training tasks in the table. During the FPTD evaluation, the NAA would accept or reject the use of the FPTD for each listed task. This will prevent wasting time in trying to determine every task that the device could be capable of when the operator only intends to utilize the device for a limited list of tasks. The document should be considered to be a "living" document allowing the operator to approach the NAA for changes.

Table M-1. FPTD requirements

APP A #	*REQUIREMENT*	*COMMENTS*
1.1	COCKPIT LAYOUT AND STRUCTURE	
	An open, enclosed or perceived to be enclosed cockpit area with helicopter-like primary and secondary flight controls, engine and rotor controls, equipment, systems, instruments, panels and associated controls sufficient for the training tasks to be accomplished, assembled in a spatially representative manner as that of the helicopter.	The assembled components should be compatible and function in a cohesive manner. FPTD instruments and/or instrument panels using electronically displayed images with or without physical overlay or masking are acceptable. Operable controls should be incorporated if pilot input is required during training events. The instruments displayed should be free of quantization (stepping). If installed, helicopter-like controls, instruments and equipment corresponding to the helicopter being simulated. If the FPTD is convertible, some may have to be changed for some conversions. Circuit breakers required for any training event should be functionally representative of those in the helicopter and the effects should be accurate. Circuit breaker panels, if provided, do not need to be correctly located spatially. Circuit breakers presented in a flat panel display should be considered as “functionally representative” towards procedural knowledge training credits (see Table M-2 below).
1.2	SEATING	
	Flight crew member seats should provide the crew member(s) with a representative design eye position and posture at the controls, if fitted, and in relation to equipment and instruments, as applicable, appropriate for the helicopter. In addition to the flight crew member and instructor station seats, two suitable seats should be provided for an observer and NAA inspector.	Seats may be as simple as a regular chair.

APP A #	*REQUIREMENT*	*COMMENTS*
1.3	COCKPIT LIGHTING	
	Lighting environment for panels and instruments should be sufficient for the operation being conducted.	
2.	FLIGHT MODEL	
2.1	The device is not required to fly, but, if applicable, aerodynamic and engine modelling should be broadly representative of the helicopter being simulated and of sufficient fidelity to support the intended training.	
4.0	AIRCRAFT SYSTEMS (ATA)	
4.1	NORMAL, ABNORMAL AND EMERGENCY SYSTEMS OPERATION	
	Systems represented in the FPTD should simulate the helicopter system(s) operation including system interdependencies, both on the ground and in flight, as applicable. At least one helicopter system should be represented.	Once activated, proper systems operation should result from system management by the crew member and should not require any further input from the instructor's controls. There is no requirement for other than normal system operation unless required by the operator’s approved training programme.
4.2	INSTRUMENT INDICATIONS	
	As or if applicable, any relevant instrument indications involved in the simulation of the helicopter should automatically respond to control movement by a flight crew member or auto flight device including autopilot system.	The device is not required to fly.
4.3	COMMUNICATIONS, NAVIGATION, CAUTION AND WARNING SYSTEMS	
	If installed, communications, navigation, caution and warning equipment should be helicopter-like with operation within the tolerances prescribed for the applicable equipment.	If installed, as a minimum, helicopter-like communications, navigation, and caution and warning equipment corresponding to the helicopter being simulated. If the FPTD is convertible, some equipment may have to be changed for some conversions.
5.	FLIGHT CONTROLS AND FORCES	
5.3	(FLIGHT) CONTROL SYSTEM OPERATION	
	If installed, the flight control system should be helicopter-like, and should allow basic helicopter operation with appropriate resultant cockpit indications. Force feedback not required.	If installed, as a minimum, as per Appendix A, flight controls should have a “G” fidelity level except that the controls should correspond to the helicopter being simulated.

6.	SOUND CUES	
6.1	SOUND SYSTEM	
	If installed, any significant cockpit sounds simulated during normal and abnormal operations should be helicopter-like, corresponding to the helicopter being simulated, and may include engine, transmission, rotor and airframe sounds as well as those which result from pilot-induced or instructor-induced actions.	If installed, as a minimum, as per Appendix A, sound cues should have a “G” fidelity level, except that the sound should be helicopter-like corresponding to the helicopter being simulated. An SOC is not required.
6.4	SOUND VOLUME	
	The volume control should have an indication of sound level setting which meets all qualification requirements. Full volume should correspond to actual volume level agreed at the initial evaluation. When full volume is not selected, an indication of abnormal setting should be provided to the instructor.	If a sound system is installed.
7.	VISUAL DISPLAY CUES	Not required, but if installed, as a minimum, it should meet the visual cues requirements of Appendices A, B and C at a “G” fidelity level.
10	ENVIRONMENT – NAVIGATION	
	If applicable, navigational database with the corresponding departure, en-route and approach facilities and procedures within the planned area of operations. Navigation aids should be usable within range or line of sight without restriction, as applicable to the geographic area.	Navigational database should be maintained with regular updates, as mandated by the NAA for such a system.
13.	ENVIRONMENT – ATC (VOICE)	Not required, but if installed, as a minimum, it should meet the Environment — ATC requirements of Appendices A, B and C at a “G” fidelity level.
14	MISCELLANEOUS	
14.2	INSTRUCTOR CONTROLS	
	Instructor controls for all required system variables, freezes, and resets and for insertion of malfunctions to simulate abnormal or emergency conditions, as appropriate.	
14.4	COMPUTER CAPACITY	
	Sufficient FPTD computer capacity, accuracy, resolution and dynamic response to fully support the overall FPTD fidelity needed to meet the intended training.	

APP A #	*REQUIREMENT*	*COMMENTS*
14.6	UPDATES TO FPTD HARDWARE AND SOFTWARE	
	Timely permanent update of FPTD hardware and software subsequent to FPTD manufacturer recommendation where it affects training and/or safety.	
14.7	DAILY PRE-FLIGHT DOCUMENTATION	
	Daily pre-flight documentation either in the daily log or in a location easily accessible for review is required.	

Note.— The non-sequential numbering in Table M-1 first column reflects the same numbering as for the requirements listed in Appendix A.

Table M-2. Suggested list of training and checking tasks for an FPTD
(Company name) FPTD ID #__

LEGEND

N – device is not suitable or not applicable to task
1 – suitable for procedural knowledge training.
2 – suitable for skill training related to task (T).
3 – suitable for manoeuvre training and checking for the task (TP).

Event	*1*	*2*	*3*
Preparation for flight			
Functional check (pre-flight inspection)			
Pre-flight cockpit inspection			
Pre-start checks			
Programme helicopter automation			
Set-up navigation aids and communications equipment			
Surface operations (pre-take-off)			
APU/engine start and run-up			
Normal start			N
Alternate start procedures			N
Abnormal starts and shutdowns			N
Rotor start/engagement and acceleration			
Rotor start/engagement and acceleration		N	N
Rotor engagement		N	N

Event	*1*	*2*	*3*
After start systems checks			N
Taxi — Ground			
Collective lever/cyclic friction		N	N
Power to taxi/cyclic input		N	N
Brake operation (normal, alternate, emergency)		N	N
Ground handling		N	N
Water taxi/handling (if applicable)		N	N
Tail/nosewheel lock operation			
Taxi aids (e.g., moving map)			
Pre-take-off checks			N
Other			
Taxi — Hover/air taxi			
Lift-off characteristics		N	N
Hover characteristics, engine and flight instrument response			
In ground effect (IGE)		N	N
Out of ground effect (OGE)		N	N
Hover power checks			
In ground effect (IGE)		N	N
Out of ground effect (OGE)		N	N
Hover turns			
Spot turns		N	N
Turns about the nose		N	N
Turns about the tail		N	N
Anti-torque effect/directional control effect		N	N
Translating tendency		N	N
No wind/headwind/crosswind /tailwind hover		N	N
Critical azimuth		N	N
Air Taxi/transit/translational flight			
Forward		N	N
Sideward		N	N
Rearward		N	N

Event	*1*	*2*	*3*
Take-off and departure			
Normal			
From ground		N	N
From hover			
CAT A and/or PC1/PC2 for all certified profiles		N	N
CAT B or PC3		N	N
Running		N	N
Crosswind/tailwind		N	N
Maximum performance		N	N
MCTM		N	N
Confined area		N	N
Slope		N	N
Obstacle clearance		N	N
Elevated heliport/platform/helideck/pinnacle		N	N
Vertical		N	N
Automation management			N
Transition to forward flight		N	N
Post-departure checks			
Abnormal/emergency procedures			
Engine failure		N	N
Rejected take-off			
Over land		N	N
Over water (if float equipped)		N	N
CAT A and/or PC1/PC2			
Engine failure prior to TDP		N	N
Engine failure at or after TDP		N	N
Instrument departure			N
Other			
Climb			
Normal			N
Obstacle clearance		N	N
Best rate		N	N
Best angle		N	N

Event	*1*	*2*	*3*
Vertical climb		N	N
One engine inoperative		N	N
Level-off			N
CAT A and/or PC1/PC2 operation for all certified profiles with engine failure up to 300 m (1 000 ft) above heliport elevation		N	N
Other			
Cruise			
Performance characteristics			
Straight and level flight			N
Low speed flight (not below ETL speed)		N	N
Accelerations and decelerations			N
High speed warnings			N
Turns			
Normal			N
Standard rates (rate ½, 1 and 2)			N
Steep (30° and 45° of bank)		N	N
Flight controls servo actuator transparency effects		N	N
Descent and arrival			
Normal descent			N
Maximum rate		N	N
Autorotative			
Straight in		N	N
With turns		N	N
IMC		N	N
To landing		N	N
Power recovery		N	N
Instrument arrival			N
Instrument approaches and landing			
Precision approaches to DH/DA (all engines operating)			
ILS			
CAT I – Autopilot			N
CAT I – Manual			N
With flight director			N

Event	*1*	*2*	*3*
Without flight director			N
CAT II			
Auto-coupled (3 axes)			N
Auto-collective (4 axes)			N
DGPS/GLS			N
PAR			N
HUD/EFVS			N
Other			
Precision approaches OEI		N	N
Non-precision approaches to MDA (all engines operating)			
With autopilot			
Surveillance radar approach			N
ARA			N
NDB			N
VOR, VOR/DME, TACAN			N
RNAV/RNP/GNSS/RNP APCH/ RNP APCH AR/PINS/			N
ILS LLZ (LOC), LLZ back course (or LOC-BC)			N
ILS offset localizer/SDF			N
Circling (approach prior to the visual segment)			N
Without autopilot			
With FD			
ARA			N
NDB			N
VOR, VOR/DME, TACAN			N
RNAV/RNP/GNSS/RNP APCH/ RNP APCH AR/PINS			N
ILS LLZ (LOC), LLZ back course (or LOC-BC)			N
ILS offset localizer/SDF			N
Circling approach (prior to the visual portion)			N
Without FD			
Surveillance radar approach			N
ARA			N
NDB			N
VOR, VOR/DME, TACAN			N

Event	*1*	*2*	*3*
RNAV/RNP/GNSS/RNP APCH/ RNP APCH AR/PINS			N
ILS LLZ (LOC), LLZ back course (or LOC-BC)			N
ILS offset localizer/SDF			N
Circling approach (prior to the visual segment)			N
HUD/EFVS			N
Missed approach			
All engines, manual and autopilot coupled			N
Engine(s) inoperative, manual and autopilot coupled			N
With autopilot/stability augmentation system failure			N
Non-precision approaches OEI		N	N
Visual approaches			
Normal			
With VASIS/PAPI		N	N
Without VASIS/PAPI		N	N
Steep		N	N
Shallow		N	N
Elevated landing site		N	N
Helideck on ship or rig		N	N
Confined area		N	N
Crosswind/tailwind		N	N
Visual circling to land manoeuvre after an instrument approach		N	N
Quick stop		N	N
Forced landing approach		N	N
Transition to hover		N	N
HUD/EFVS			N
Other			
Balked landing			
All engines operating		N	N
OEI		N	N
Balked rig or deck landing		N	N
CAT A or PC1/PC2 operation for all certified profiles from 300 m (1 000 ft) above heliport elevation to or after LDP		N	N

Event	*1*	*2*	*3*
Landing transition/touchdown			
From a hover		N	N
Running		N	N
Slope		N	N
Crosswind/tailwind		N	N
Elevated heliport/platform/helideck/pinnacle		N	N
From a visual approach		N	N
From an instrument approach		N	N
From autorotation		N	N
CAT A operation (PC1/PC2)			
Landing with engine failure prior to LDP		N	N
Landing with engine failure at or after LDP		N	N
Engine shutdown and parking (including applicable checks)			
Engine and systems operation			
Parking brake operation			
Rotor disengagement and deceleration			N
Rotor brake operation			N
Other			
Any flight phase			
Air conditioning and ventilation			
Autopilot and flight director			
Normal flight dynamics			N
Abnormal flight dynamics		N	N
Stability augmentation system			
Normal flight dynamics			N
Abnormal flight dynamics		N	N
Communications			
Electrical system			
Fire and smoke detection and suppression			
Flight controls			
Normal flight dynamics			N
Abnormal flight dynamics		N	N

Event	*1*	*2*	*3*
Flight control computers (CCH)			
Normal flight dynamics			N
Abnormal flight dynamics		N	N
Stabilizer/stabilator			
Normal flight dynamics			N
Abnormal flight dynamics		N	N
Fuel and oil			
Hydraulic			
Normal flight dynamics			
Abnormal flight dynamics		N	N
Anti-icing/de-icing			
Landing gear			
Normal operation			
Alternate/emergency/floats operation			N
Lighting			
Oxygen			
Pneumatic			
APU			N
Engine			
Normal flight dynamics			N
Abnormal flight dynamics		N	N
Transmissions			
Normal flight dynamics			N
Abnormal flight dynamics		N	N
Radar			
Collision/terrain avoidance systems (HTAWS, EGPWS, GPWS, TCAS)			N
Flight data display/annunciation			
Flight management and guidance systems			
Flight director/system displays			
Conventional			N
HUD (including EFVS, if applicable)			N
Navigation systems			

Event	*1*	*2*	*3*
Wind shear avoidance		N	N
EFB		N	N
Electronic checklists			
Normal operations			
Abnormal/emergency operations		N	N
Voice activated systems			
Other			
Airborne procedures and malfunctions			
Holding			
Air hazard avoidance			N
Quick stop		N	N
Mast bumping		N	N
Loss of directional control		N	N
Loss of anti-torque effectiveness		N	N
Vortex ring/settling with power		N	N
Ground resonance		N	N
Autorotation		N	N
IMC autorotation		N	N
Inadvertent entry into IMC			N
Recovery from unusual attitudes		N	N
Partial panel			N
Rotor, airframe and engine icing		N	N
Ditching		N	N
Wind shear/microburst			N
Airborne weather radar			N
Engine failure - restart			N
Other			
Stability augmentation malfunction in flight		N	N
Autopilot malfunction in flight		N	N
Engine fire			
On ground			N
Rotor brake fire			N
In the hover		N	N

Event	*1*	*2*	*3*
Engine fire in forward flight			N
Engine malfunctions		N	N
Airframe fire and smoke		N	N
On ground			N
In the hover		N	N
Airframe fire and smoke in forward flight			N
Engine failure before CDP/rejected take-off		N	N
Engine failure at or after CDP (multi-engine)		N	N
OEI instrument approaches and go-around		N	N
OEI instrument approaches and landing		N	N
Autorotation to engine off landing		N	N
Incipient vortex ring/power settling at altitude		N	N
Incipient vortex ring/power settling on approach		N	N
MGB/IGB/TRGB chip detector/oil pressure warning in the hover			N
MGB/IGB/TRGB chip detector/oil pressure warning in forward flight			N
Hydraulic failure in the hover		N	N
Hydraulic failure in forward flight			N
Hydraulic jack stall (servo transparency)		N	N
Instrumentation/indication failure in VMC			N
Instrumentation/indication failure in IMC			N
DC system failure			N
AC system failure			N
Battery failure			N
Total electrical failure			N
Fuel transfer failure			
Fuel supply malfunction			N
Landing gear malfunction			N
Coupled control malfunction		N	N
Uncoupled control malfunction		N	N
ECU failures		N	N
Other			

Instructor operating station (IOS)		**Y**	**N**
Power switch(es)			
Helicopter conditions:			
Mass, CG, fuel quantity, etc.			
Helicopter systems status			
Ground crew functions			
Aerodromes and landing areas:			
Number and selection	#:		
Runway selection			
Runway (and other) surface condition			
Preset positions			
Lighting controls			
Environmental controls:			
Day/night/dusk or dawn			
Clouds (base and top)			
Visibility			
Runway visual range			
Temperature			
Wind speed and direction			
Helicopter system malfunctions			
Insertion/deletion			
Clear/reset malfunction			
Locks, freezes, repositioning:			
Problem freeze/release			
Position freeze/release			
Repositioning			
Ground speed control			
Remote IOS			
Sound controls			
On/off/rheostat			
Observer stations			

Attachment N

ALTERNATE REFERENCE LINE EVALUATION METHOD FOR FLIGHT CONTROLS DYNAMICS EVALUATION

1. BACKGROUND

When evaluating a flight control dynamic response, the periods, amplitudes and residual band are defined with respect to a reference line, which is the steady state value of the control. This selection is made since it is assumed that the steady state value is representative of the control's rest position throughout the test. For standard irreversible control systems this is very often a valid assumption. However, in the case of reversible control systems for example, aerodynamic forces on the control surfaces influence the instantaneous rest position[1] of the control. During the dynamic test, the control's rest position will vary in response to the variance of the flight conditions. In such a case, the instantaneous rest position and steady state value at the end of the test are not equivalent. When the tolerances are applied to the entire dynamic response based on the steady state value, they may become incorrect and lead to problems evaluating the cases.

2. ALTERNATE REFERENCE LINE

2.1 In such cases, an alternate reference line may be used, which attempts to better approximate the true rest position of the control throughout a step response. That reference line is obtained as described in the rest of this paragraph.

2.2 On the control position curve, identify median points, defined as points on the control position curve located equidistantly between two consecutive peaks, measured vertically (see Figure N-1). The last median point is the first point where the dynamic portion of the response has ended rather than the mid-point between the last peak and the end of the dynamic portion.

2.3 Join the median points to produce the "line of medians." Then, identify reference points, defined as the intersection of a vertical line passing through a position peak and the line of medians (see Figure N-2).

2.4 The first reference point is the last control position before the start of the excitation. When this part of the data is not available, project the first available reference point horizontally to time zero. The last reference point is simply the last median point.

2.5 Link all the reference points to obtain the alternate reference line (see Figure N-2), and append the final non-dynamic portion to it.

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1. The rest position is defined as the position where the blade would eventually settle if no pilot force were applied to it (left free). This position may or may not be affected by the aerodynamic conditions, the helicopter configuration (landing gear up or down) and the accelerations it is subjected to. It will depend on the type of flight control system in the helicopter. Typically, reversible control systems will be affected while irreversible systems will not. The instantaneous rest position is defined as the theoretical rest position at a particular point in time and at the same conditions of that moment.

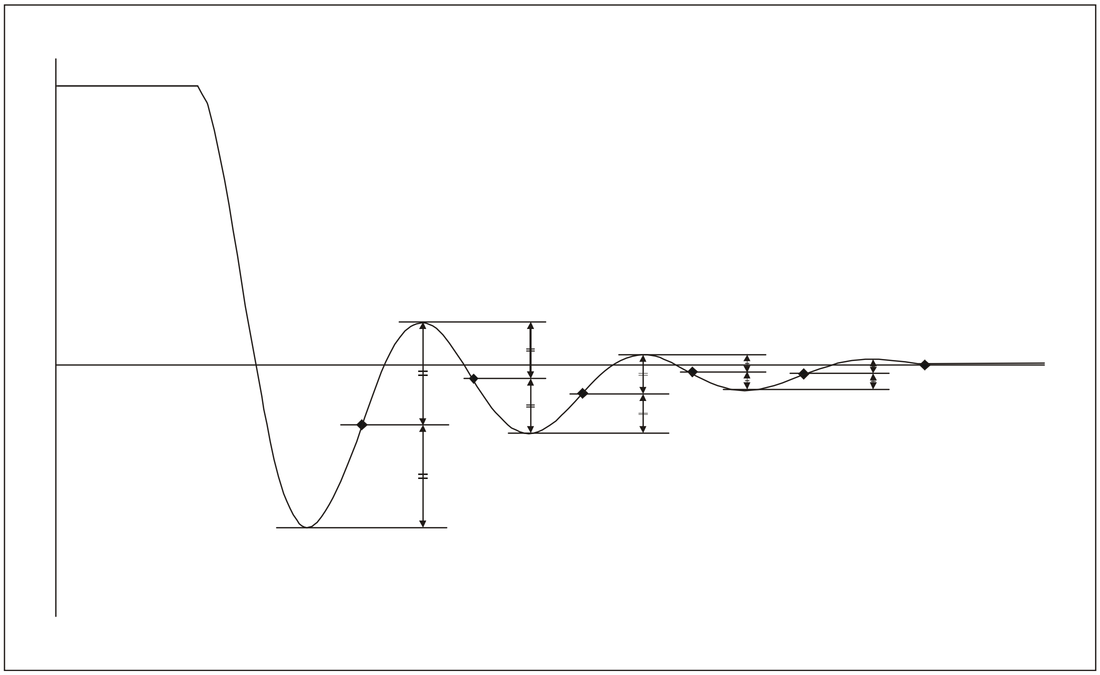

Figure N-1. Locating median points

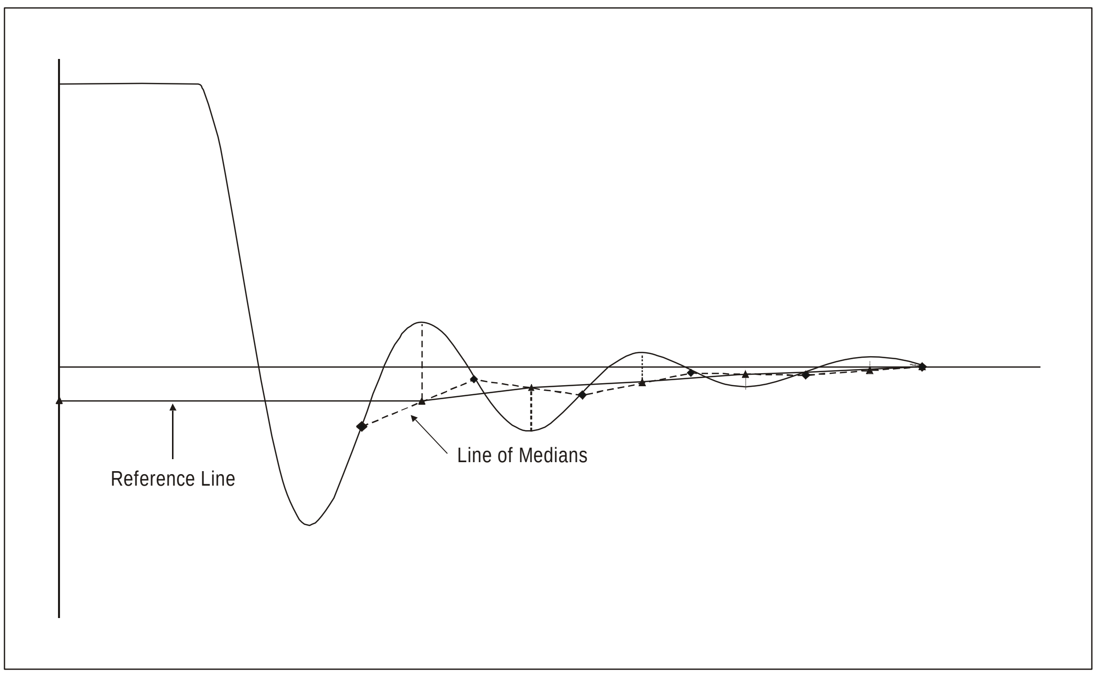

Figure N-2. Producing the final alternate reference line

3. TOLERANCES

The final alternate reference line (see Figure N-3) may be used to calculate the conventional tolerances described in Appendix B to this Part, paragraph 3.2.2.2. Note that the residual band $T(A_d)$ must be at a distance of 5 per cent of A_d or 0.5 per cent of the total control travel (stop to stop) from the alternate reference line. Its shape will therefore follow the alternate reference line.

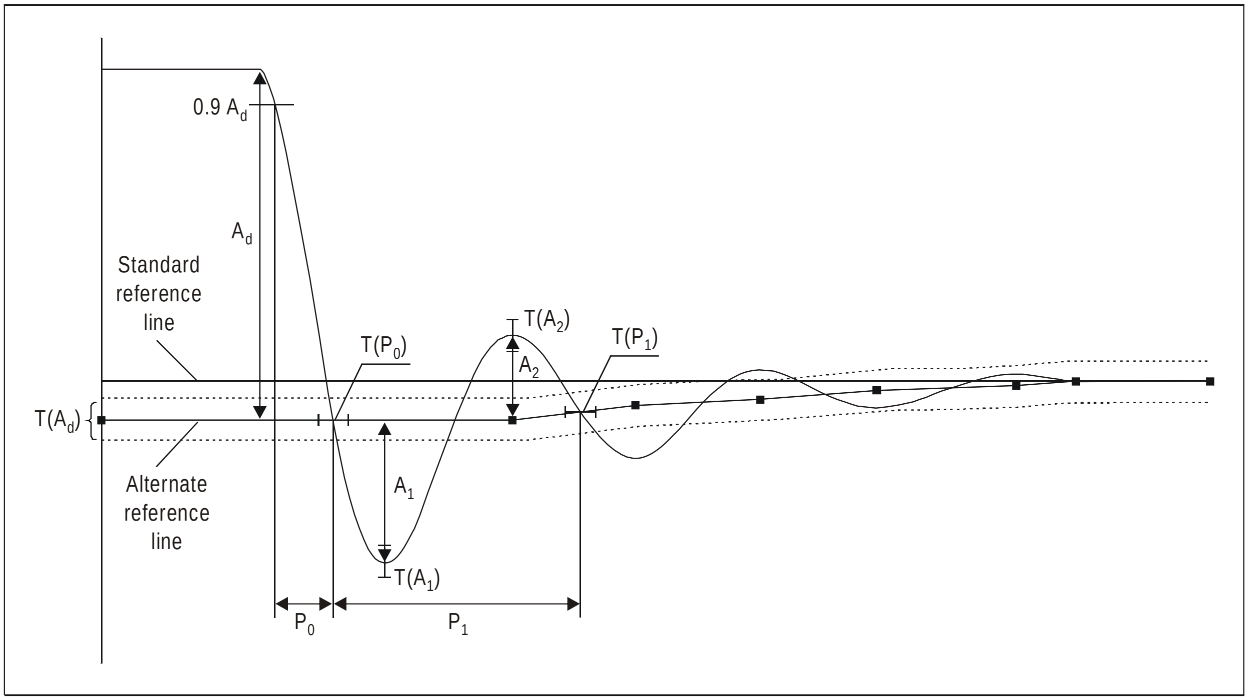

Figure N-3. Tolerances applied using the alternate reference line

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Attachment O

GUIDANCE FOR ENVIRONMENT — ATC

For the highest fidelity of simulation (Specific), it is recognized that the flight simulation and training industry is currently developing technology applications and training requirements to include ATC environment simulation into FSTDs. However, the use of ATC environment simulation at the highest fidelity of simulation in FSTDs is still in the development stage of its life cycle. Suitable guidance material will be written and published in an update to this document when sufficient experience has been gathered and the requirements reviewed by industry.

Appendices A, B and C in Part III of this document contain temporary material for ATC environment simulation requirements and testing that should not be treated as prescriptive for FSTD qualification at this time. The content of these three appendices should be used as guidance to industry for the continued development of ATC environment simulation for FSTDs.

Attachment P

GUIDANCE FOR VIBRATIONS

1. BACKGROUND

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

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

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

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

2. LIMITATIONS OF USING A 6 DEGREE-OF-FREEDOM MOTION SYSTEM TO REPRODUCE VIBRATIONS

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

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

3. ADVANTAGES OF A DEDICATED 3 DEGREE-OF-FREEDOM VIBRATION PLATFORM

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

3.2 Two solutions may be used for simulating the vibration with 3 DOFs:

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

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

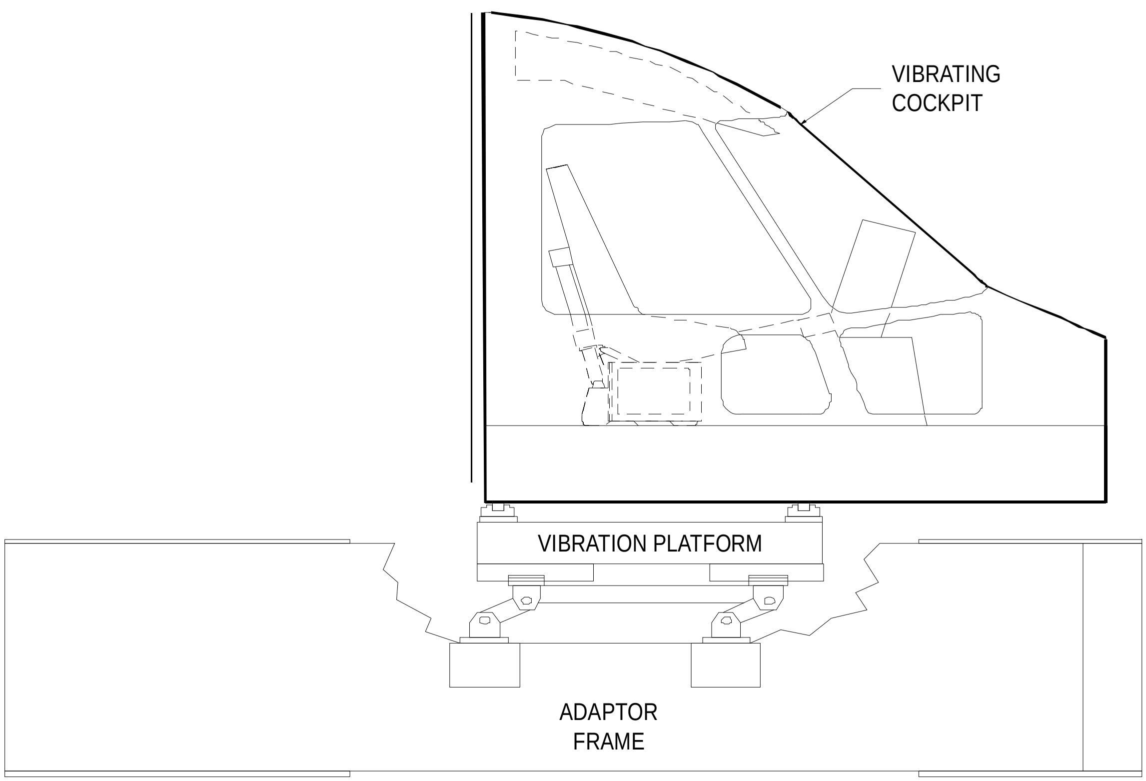

Figure P-1. An example of a three degree-of-freedom cockpit vibration system

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Attachment Q

MOBILE FSTDs

1. BACKGROUND

A mobile FSTD is such that the FSTD and all ancillary associated equipment necessary for its independent operation are installed on a self-contained platform. The mobile FSTD is designed to be moved to different locations, with limited disassembly or detachment, and to be rendered operational with no unintended effect on its previous qualification status (refer also to Part II, Chapter 2, 2.11.5). Depending on the design and mode of transportation (e.g. by ground, air or sea), the movement of such a complex system may cause variance from the previous results with which the FSTD was qualified. The intent is to ensure that the original subjective and objective criteria remain satisfied. The relocation of a fixed FSTD, which would normally require a full requalification, is not covered in this attachment.

2. QUALIFICATION PROTOCOL FOR MOBILE FSTDS

2.1 To ensure that the basis for the original evaluation remains valid at a new location, the NAA will conduct another evaluation after the device has been moved. If both evaluations are successful then an initial qualification can be granted.

2.2 In addition, the FSTD operator should provide the NAA with a quality management system plan, beyond that of a standard FSTD, which ensures that all aspects of mobility are addressed. Pre- and post-move checklists should be agreed upon with the NAA. The quality management system plan should ensure as a minimum that:

- all prescribed checks are undertaken successfully before and after every move;
- subsystems that may have to be detached to facilitate the mobility of the FSTD are inspected or tested before use, after every move;
- consideration is given to effects of the external environment during and after the move of the FSTD − the effects should include issues emanating from sound, power supply, grounding, isolation, light, temperature, humidity, etc.; and
- additional consideration is given to local regulations, such as fire certification, health and safety.

2.3 The goal is for the NAA to gain a high degree of confidence that the FSTD performance is maintained after successive moves.

Attachment R

GUIDANCE ON VISUAL DISPLAY SYSTEM FIELD OF VIEW AND DISPLAY METHOD

1. APPLICABILITY

1.1 This attachment applies to all FSTDs with a cross cockpit display installation, meaning a display that can be viewed as a continuous image from any location in the cockpit.

1.2 For the purpose of this attachment, "***collimated display***" will be used as a generic term for a display system that provides an image apparently located at a distance substantially further away from the pilot than the physical dimensions of the display system, and "***direct projected display***" refers to a display system with an image actually located on a screen in front of the pilot.

2. FIELD OF VIEW REQUIREMENTS

2.1 For the higher fidelity level ("S") of the visual display cue feature, an FOV of 210° horizontally by 60° vertically is required. The vertical FOV should generally have approximately 1/3 of the image above and 2/3 below the horizon consistent with best filling the available cockpit window areas.

2.2 The field of view requirements of 2.1 should cover the majority of training tasks; however there are cases where larger fields of view may be required for manoeuvres associated with specific operations, such as air rescue, medical evacuation, confined area or sloping ground landings, take-offs and landings in snow, sand or dust, rig or ship take-offs, departures, approaches and landings.

2.3 For an "R" fidelity level of the visual display cue feature, an FOV of 180° horizontally by 45° vertically is required. The vertical FOV should generally have 1/3 of the image above and 2/3 below the horizon.

2.4 For a "G" fidelity level of the visual display cue feature, an FOV of 45° horizontally by 30° vertically is required.

3. DISPLAY METHOD

3.1 Two basic display types are discussed.

3.2 *Collimated display*: where the image projected on a screen is viewed via a large concave mirror which, as a result of its position and curvature, places an apparent image at greater than 10 m (33 ft) from the observer. The result of such a display is that the image on this type of screen will behave as if all the objects in the scene were at more than 10 m (33 ft) from the observer (see Figure R-1). As a result, when the observer moves his or her head, the objects will appear to follow the observer's head movements in the same way as in the real world. Ten metres (33 ft) is the maximum distance that it is considered possible to judge distance by binocular cues.

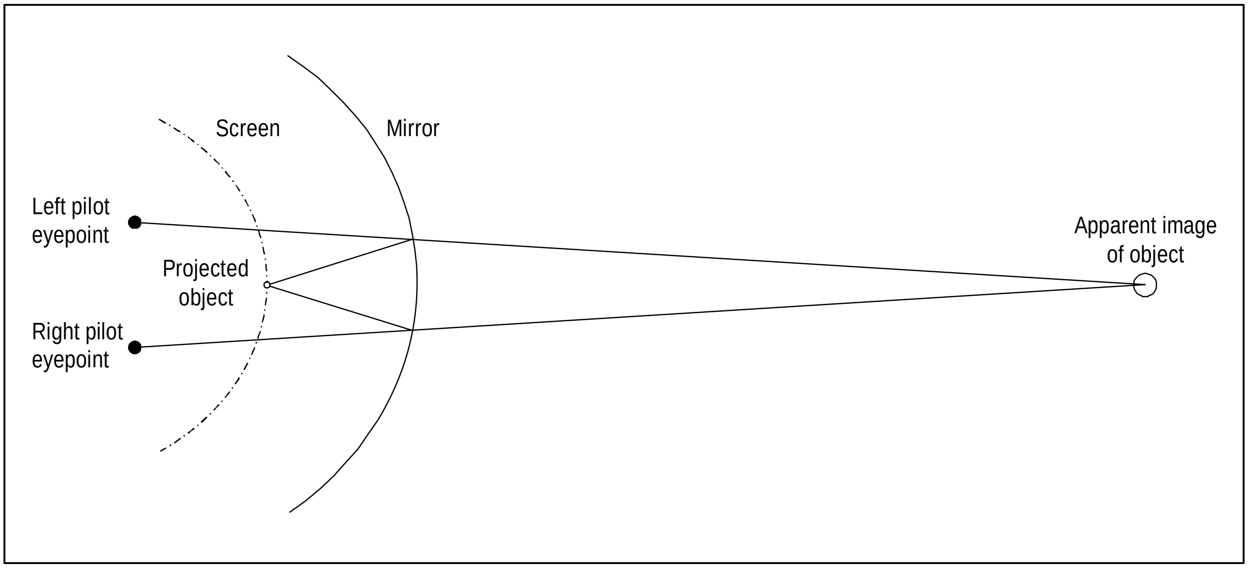


Figure R-1. Collimated display

3.3 *Direct projected display*: where the image is directly projected onto a screen generally about 3 m from the observer and, as required by the field of view, cylindrical or spherical in shape. The image on this type of screen will behave as if all the objects in the scene were at 3 m from the observer. It should be noted that the minimum radius of the screen and the position of the cockpit relative to the screen may be determined from the allowed angular errors for the pilot(s). In the example illustrated by Figure R-2, if the criterion is to have no more than 10° offset for both pilots simultaneously, then for an eyepoint at the centre of a spherical screen, where the pilots' eye spacing is a typical 1.168 m (46 in.), the screen radius must be at least 1.168/(2*Tan10°) = 3.312 m (10.9 ft).

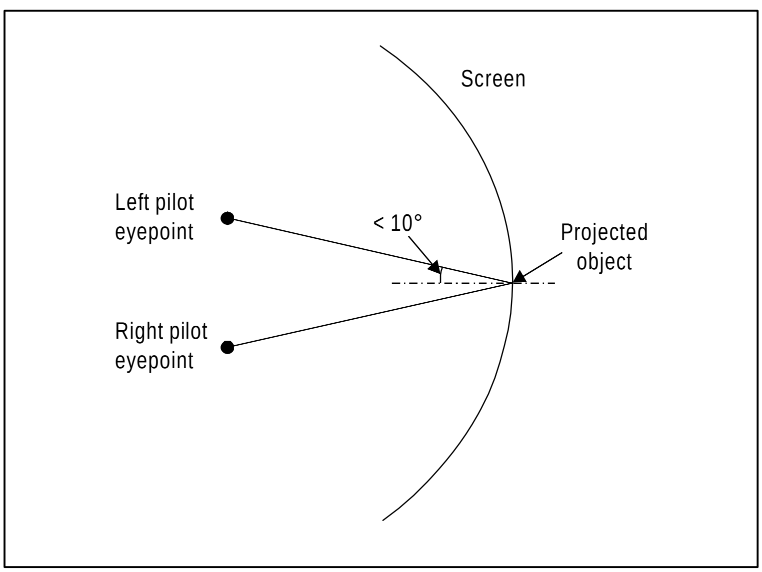


Figure R-2. Direct projected display (image centrally aligned)

Note.— In both cases in 3.2 and 3.3, the perspective relationship of objects within the image is correctly maintained (although for only the left or right eyepoint location in the case of the "direct projected display").

4. CRITERIA FOR DETERMINING DISPLAY METHOD

4.1 Each display type has different attributes and neither can be the ideal solution for all training tasks. The choice of display therefore depends upon which trade-off best suits a particular training programme.

4.2 Collimated display

4.2.1 Today's collimated displays have limited fields of view within the main display (220° x 60° is typically the maximum). The downward FOV can be increased in certain applications with the use of separate "chin window" displays; however these are generally not ideal as there will be a discontinuity between the two display areas.

4.2.2 The primary attribute of a collimated display is that both pilots in a side-by-side configuration will see scene objects in generally the same angle of azimuth ("look direction"). This would mimic the real world for all phases of flight, except when operating at low speed or in a hover, close to the ground or next to an object, where peripheral visual cues become more important.

4.2.3 While there are some angular errors inherent to the optical design of collimated displays, these are typically on the order of up to three degrees, so this type of display will provide an essentially correct orientation of the view to all cockpit occupants. However, as the image is collimated at a distance greater than 10 m (33 ft) from the observers, when operating near the ground, parts of the image could then potentially be trying to represent objects as close as 2.5 m (8 ft) away (depending on the aircraft dimensions). This creates a conflict between the binocular cues and the monocular static and motion-based cues. Of these two cue classes, for most phases of aviation the monocular cues are generally dominant as long as the object is recognizable as a known size and shape.

4.3 Direct projected display

4.3.1 In single pilot training exercises a direct projected image would be the optimum solution.

4.3.2 Direct projected displays have the advantage that the distance from the eyepoint to the display screen is likely to be closer to reality when operating at low speed close to objects or to the surface. Conversely, for simulated objects at great distance, any head motion would result in the distant object appearing to behave incorrectly.

4.3.3 The major limitation of direct projected displays is that they cannot be simultaneously correct for more than one observer. If two pilots are using the same projected display and the image is aligned to the pilot flying then the pilot not flying could have a parallax error of up to 20° for a typical dome size, as illustrated in Figure R-3.

4.3.4 Finally, direct projected displays offer the potential for larger fields of view, which are advantageous for both single and dual pilot operations.

4.3.5 The flowchart in Figure R-4 may assist in deciding the best display system for the FSTD but should not be used as the only method of defining the best display for a particular training requirement.

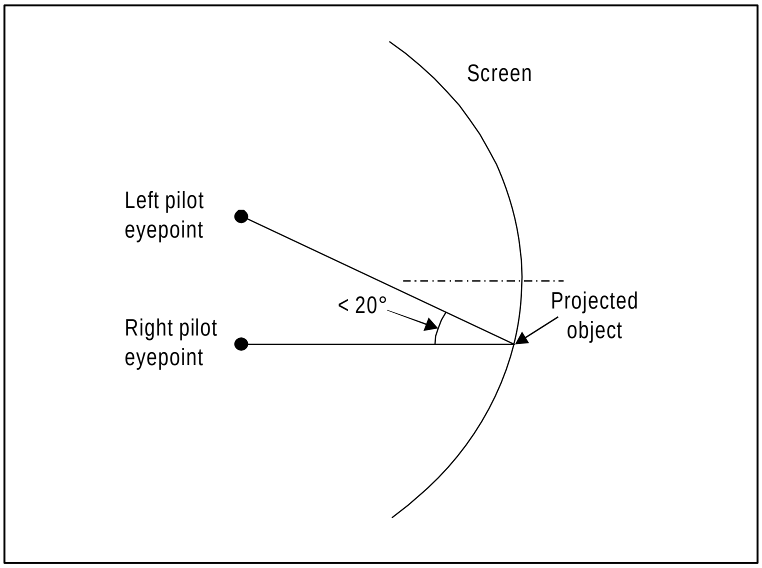


Figure R-3. Direct projected display (image aligned to right pilot eyepoint)

5. SUMMARY

5.1 Both display types have their strengths, and any choice will be a "trade-off" to gain the best fit to the training requirement. The topics can be summarized as:

- The image distance issues do not represent the only factor to be considered. Neither display type is ideal for helicopter simulation. The availability of peripheral cues and the level of details in the scene are also very important. Rich scene information is now available from high quality image generators and this capability is likely to improve.

- When an operation is required with a crew of two pilots, collimated displays may be the preferred choice unless a large vertical field of view is essential.

- For single pilot operation, direct projection is likely to be the optimum solution.

5.2 If a direct projected system is used for a multi-pilot operation then one pilot would be designated as "pilot flying" and the other as "pilot not flying". The image generator could then be set up to ensure that only the pilot flying has the correct view (bearing in mind that the maximum offset allowed for the pilot not flying is 20°). Should it be required to switch the "pilot flying" function to the other pilot, the image could be re-aligned to give the correct view to the new "pilot flying" eyepoint. A two-pilot training operation using a direct projection system may be best served without offsetting the eyepoint, i.e. with both pilots having up to 10° offset. The decision to use a centrally aligned display is dependent upon the need for the handling pilot to use linear visual features.

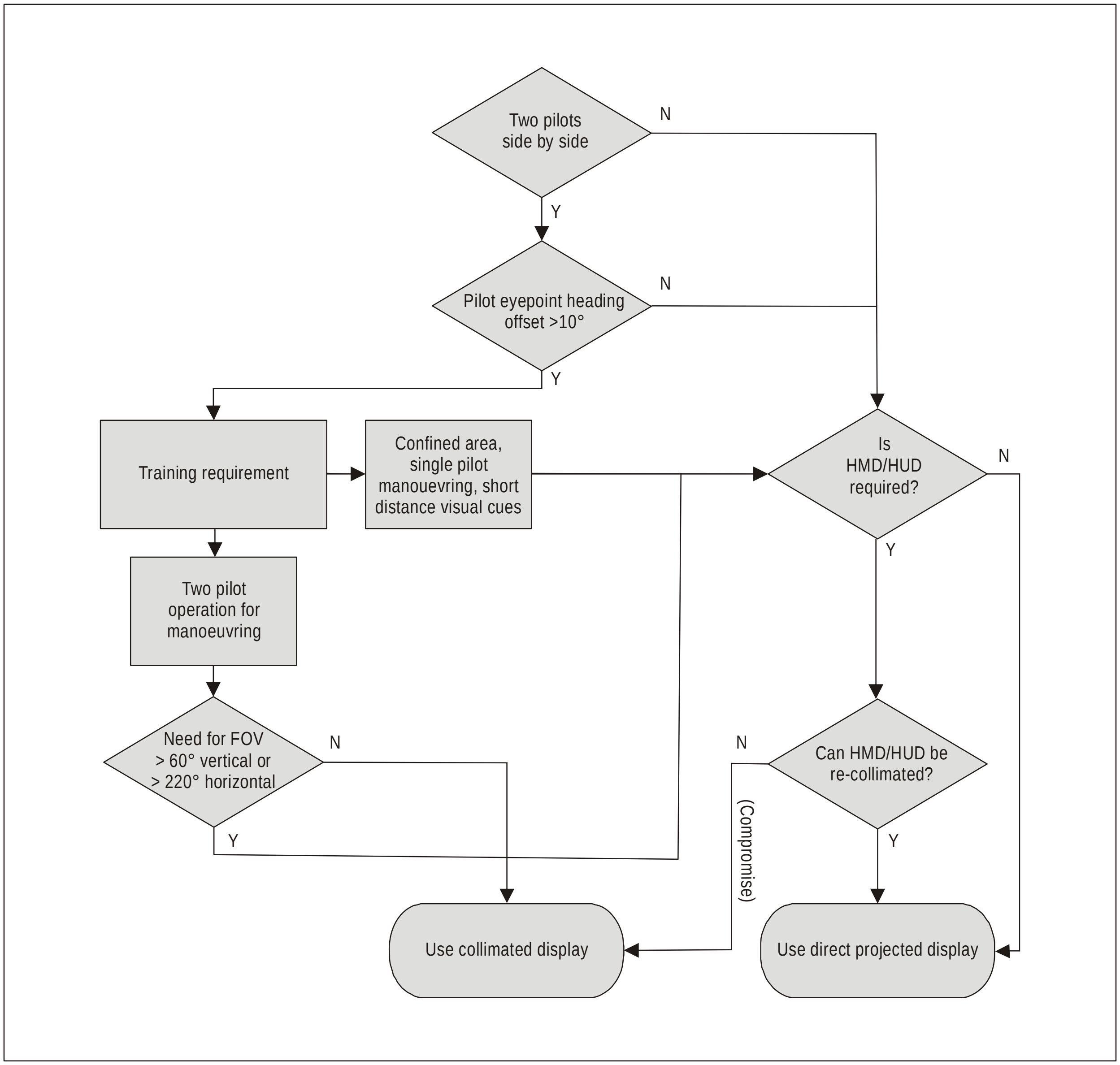


Figure R-4. Flowchart guidance for the most suitable display system

6. OTHER CONSIDERATIONS

6.1 An area that is relevant to helicopter simulation is that it may be more cost effective to be able to move FSTDs to the location of small operators who cannot justify the cost of an FSTD for comparatively small fleets. This means that the FSTD needs to be transportable or mobile (see Attachment Q to this Part for guidance on mobile FSTDs). The primary problem with moving FSTDs is the size of the display device, as to achieve either a collimated image or a real image with a large field of view and a small parallax error generally requires mirrors or screens in excess of 6.1 m (20 ft) in diameter.

6.2 Consideration should be given to allowing minimal gaps (< 1/2 degree) in the “continuous view” to allow screens to be broken down into smaller parts for transport. Generally two joins per system should be adequate. This could be applied to a directed projected display or to a collimated display, though there may be technical difficulties with collimated systems.

MANUAL OF CRITERIA FOR THE QUALIFICATION OF FLIGHT SIMULATION TRAINING DEVICES

Volume II
Helicopters

Part III
Flight Simulation Feature and Fidelity Level Criteria

Chapter 1

GLOSSARY OF TERMS, ABBREVIATIONS AND UNITS

Refer to Volume II, Part II, Chapter 1.

Chapter 2

INTRODUCTION

2.1 PURPOSE

2.1.1 Part III of this Volume provides the information to determine the requirements and qualification criteria for a helicopter FSTD defined, using the process described in Part I, Chapter 3 of this Volume, from the simulation features according to training task considerations. It also establishes the performance and documentation requirements for evaluation by NAAs of the defined FSTDs used for training, testing and checking of flight crew members. The process described in Part I of this Volume is new, but the requirements and methods of compliance were derived from the extensive experience of authorities and industry.

2.1.2 Part III of this Volume is intended to provide the means for an NAA to validate the definition of a new FSTD type or variant of an existing FSTD type and to qualify such an FSTD, subsequent to a request by an applicant, through initial and recurrent evaluations of the FSTD. Further, the manual is intended to provide the means for the authorities of other States to accept the qualifications granted by the State which conducted the initial and recurrent evaluation of an FSTD, without repetitive evaluations, when considering approval of the use of that FSTD by applicants from their own State.

2.2 BACKGROUND

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

2.2.2 The FSTD requirements provided in this chapter are derived from training requirements which have been developed through a training task analysis, the details of which are fully presented in Part I of this Volume. Part I also defines the process for identifying a new device that may be a variation of one of the existing device types defined in Part II of this Volume, or may be unique. This Part III provides the information to enable identification of the requirements and testing for such a new device.

2.2.3 The summary matrix example (see Table 2-1) should be used to define the new device type by correlating the appropriate training tasks for a given training type against fidelity levels for key simulation features. The resulting FSTD Types should have the capability to be used in the training and, if applicable, testing and checking towards the chosen training tasks in relation to licences or ratings. Training types that can be used for this process are those listed in Part I of this Volume, Chapter 4. The introduction of a new training type, new tasks or variations in tasks may not be supported by Part I, Part II and Part III and would require the appropriate training task analysis before it could be considered for the process used here. The terminology used in the table below for training type, device feature and fidelity level of device feature is defined in Part II of this Volume, Chapter 2, paragraph 2.2.3.

2.2.4 Training codes:

Refer to Volume II, Part II, Chapter 2, paragraph 2.2.4.

Table 2-1. FSTD Summary Matrix Example of a Δ (Delta) Device

Note.— Guidance on the qualification criteria determination process is contained in Part I of this Volume, Chapter 3.

Task Number	Device Type and Delta Competency Element or Training Task	Cockpit Layout and Structure	Flight model (Aero and engine)	Ground Handling	Helicopter Systems (ATA)	Flight controls and forces	Sound Cue	Visual Cue	Vibration Cue	Motion Cue	Environment — Navigation	Environment — Weather	Environment — Landing Areas and Terrain	Environment – ATC (Voice)
	Type V	S	S	S	S	S	R	S	S	R	S	S	S	G
	Type IV	S	S	S	S	S	R	S	S	R1	S	S	S	G
	Type III	S	S	S	S	S	R	S	R	N	S	S	S	G
	Type II (VFR)	R	R	G	R	R	G	S	G	N	S	R	R	G
	Type I (IR)	R	R	G	R	R	G	G	G	N	S	G	G	G
7.31	Tail Rotor drive failure in the hover (T)	R	R	R	R	R	N	R	N	N	N	G	G	N
7.32	Tail Rotor drive failure in forward flight (T)	R	R	R	R	R	G	R	N	R1	N	G	G	N
7.33	Tail Rotor control failure in the hover (T)	R	R	R	R	R	N	R	N	N	N	G	G	N
7.34	Tail Rotor control failure in forward flight (T)	R	R	R	R	R	G	R	N	R1	N	G	G	N
	Type II (VFR) Δ device roll-up	R	R	R	R	R	G	S	G	R1	S	R	R	G

2.2.5 Notes for the use of Table 2-1 to define the desired Δ (delta) device type:

2.2.5.1 Selection of a unique set of training tasks from Part I of this Volume, Appendix C for the desired training programme will identify the fidelity level signatures of the FSTD features for those tasks. Populating the table with these feature fidelity levels and use of the roll up process (selection of the highest fidelity level for each feature) will result in the Δ device feature fidelity signature. In the example shown in Table 2-1, a Type II (VFR) baseline device is supplemented to accommodate training (T) for a selection of tail rotor failure malfunctions, resulting in a Type II (VFR) Δ device, where the features modified from the baseline Type II (VFR) are ground handling and motion cues. Another consideration in the definition of the device is that individual feature fidelity levels cannot be treated in isolation. The training device will be used in an integrated manner and certain features may have a dependency upon other features for integrated operation. This may result in the FSTD fidelity level signature having to be altered to ensure compatibility among dependent features. Paragraphs 2.2.5.3 and 2.2.5.4 below describe the treatment of integrated feature fidelity levels for validation testing and functions and subjective testing.

2.2.5.2 Correlation of the new device feature fidelity signature against the information provided in Appendix A to this Part will provide the necessary requirements for the Δ device type.

2.2.5.3 Correlation of the new device feature fidelity signature against the information provided in Appendix B to this Part will provide the necessary validation tests for the Δ device type. Examples of the inter-dependency of features which require the same fidelity level for various integrated tests are provided in the validation test tables in Appendix B to this Part. For the purpose of evaluation, the fidelity of a set of integrated features is only as good as the lowest individual fidelity level found within that set of integrated features.

2.2.5.4 Correlation of the new device feature fidelity signature against the information provided in Appendix C to this Part will provide the necessary functions and subjective tests for the Δ device type. The functions and subjective tests are all executed in an environment where FSTD features are used in a fully integrated manner. The integrated nature of the testing environment prevents these functions and subjective tests from being classified by feature fidelity level. Where any new type of FSTD is created, it will inevitably have a collection of different feature fidelity levels in its construction, which precludes the possibility of classifying tests for those "device types" using the categories G, R and S. To avoid the possibility of confusion by associating tests for those "device types" with G, R and S, the feature fidelity levels are not presented in the table in Appendix C to this Part. Instead, the complete functions and subjective tests list as used in Part II, Appendix C of this Volume is provided with a single blank column labelled "Applicability". For any new device type created, an appropriate functions and subjective tests list will have to be defined from this master list. This should be done by analysis of the applicable training tasks that the device will support as presented in Part I of this Volume and by entering "Yes" or "No" in the "Applicability" column for each test case of the master list. This list will have to be agreed with the relevant NAA. Examples of this can be seen in Part II, Appendix C of this volume where similar exercises were conducted for device Types I to V, where a tick mark represents "Yes" and a blank cell represents "No".

2.2.5.5 The "Miscellaneous" simulation feature does not appear in the table because it is not addressed by the training task analysis. Judgement should be applied to determine which "Miscellaneous" items are required.

2.2.6 The FSTD general and technical requirements defined in Appendix A to this Part are grouped by device feature and fidelity level. The FSTD validation tests and functions and subjective tests found in Appendices B and C to this Part are grouped by relevant device feature and fidelity level.

2.2.7 If considering using this process, the appropriate NAA should be consulted very early.

2.3 RELATED READING MATERIAL

Refer to Volume II, Part I, Chapter 9.

2.4 FLIGHT SIMULATION TRAINING DEVICE QUALIFICATION

Refer to Volume II, Part II, Chapter 2, paragraph 2.4.

2.5 TESTING FOR FLIGHT SIMULATION TRAINING DEVICE QUALIFICATION

Refer to Volume II, Part II, Chapter 2, paragraph 2.5.

2.6 QUALIFICATION TEST GUIDE (QTG)

Refer to Volume II, Part II, Chapter 2, paragraph 2.6.

2.7 MASTER QUALIFICATION TEST GUIDE (MQTG)

Refer to Volume II, Part II, Chapter 2, paragraph 2.7.

2.8 ELECTRONIC QUALIFICATION TEST GUIDE (EQTG)

Refer to Volume II, Part II, Chapter 2, paragraph 2.8.

2.9 QUALITY MANAGEMENT SYSTEM AND CONFIGURATION MANAGEMENT

Refer to Volume II, Part II, Chapter 2, paragraph 2.9.

2.10 TYPES OF EVALUATIONS

Refer to Volume II, Part II, Chapter 2, paragraph 2.10.

2.11 CONDUCT OF EVALUATIONS

Refer to Volume II, Part II, Chapter 2, paragraph 2.11.

2.12 ADOPTION OF VOLUME II OF DOC 9625 INTO THE REGULATORY FRAMEWORK

Refer to Volume II, Part II, Chapter 2, paragraph 2.12

2.13 FUTURE UPDATES OF THIS MANUAL

Refer to Volume II, Part II, Chapter 2, paragraph 2.13.

2.14 EVALUATION HANDBOOKS

Refer to Volume II, Part II, Chapter 2, paragraph 2.14.

Appendix A

FSTD REQUIREMENTS

INTRODUCTION

This appendix describes the minimum FSTD requirements for qualifying a device according to international process. The validation and functions and subjective tests listed in Appendices B and C to this Part should also be consulted when determining the requirements for qualification. Certain requirements included in this appendix should be supported with a statement of compliance (SOC) and, in some designated cases, an objective test. The SOC should describe how the requirement was met. The test results should show that the requirement has been attained. In the following tabular listing of FSTD criteria, requirements for SOCs are indicated in the comments column.

1. REQUIREMENT — COCKPIT LAYOUT AND STRUCTURE

1.	FEATURE GENERAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	G	R1	R	S	COMMENTS
1.S	An enclosed full scale replica of the helicopter cockpit, which should have fully functional controls, instruments and switches to support the intended use. Anything not required to be accessed by the flight crew in any mode of operation does not need to be functional. The level of enclosure must take into account the intended use.				✓	Helicopter-like windows should be provided to exclude distractions and achieve an enclosed perception. Chin windows, if present in the helicopter, should be replicated. A device approved for NVG training would require cockpit glazing which would provide realistic reflections from internal lighting.
1.R	An enclosed or perceived to be enclosed cockpit, excluding distraction and representative of a group of helicopters to support the intended use.			✓		A device for NVG training should have cockpit glazing (reflection) if the helicopter has such characteristics.
1.G	An open, enclosed or perceived to be enclosed, cockpit, excluding distraction, which will represent that of a group of helicopters to support the intended use.	✓				

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	G	R1	R	S	COMMENTS
1.1	COCKPIT STRUCTURE					
1.1.1.S	<u>Cockpit (simulated area)</u>: An enclosed full scale replica of the cockpit of the helicopter being simulated including structure, bulkheads and panels; primary and secondary flight controls; engine and rotor controls; circuit breakers; flight instruments; navigation, communication and similar use equipment; caution and warning systems; emergency equipment and all other equipment and systems with associated controls and observable cockpit indicators. Additional required flight crew member duty stations and those required bulkheads aft of the pilots' seats containing items such as switches, circuit breakers and supplementary radio panels, to which the flight crew may require access during any event after pre-flight cockpit preparation is complete, are also considered part of the cockpit and should replicate the helicopter.				✓	<u>Cockpit (simulated area)</u>: *Note.— The cockpit, for flight simulation purposes, consists of all that space forward of a cross section of the fuselage at the most extreme aft setting of the flight crew members' seats or, if applicable, to that cross section immediately aft of additional flight crew member seats and/or required bulkheads.* Fitted systems or functions not required as part of the training programme are not required to be supported in the simulation software but any visible hardware and associated controls and switches should be fitted. Such systems, when part of any normal, abnormal or emergency cockpit procedure(s), should function to the extent required to replicate the helicopter during that procedure(s). Such systems or functions not supported in the simulation software should be identified on the FSTD QTG information page.
	<u>Instruments, panels and cockpit equipment</u>: The preceding should be properly located, functionally accurate and the tactile feel, technique, travel, effort and direction required to manipulate them within the correct range of movement, as applicable, should replicate those in the helicopter. (ctd on next page)				✓	Bulkheads containing only items such as landing gear pin storage compartments, fire axes or extinguishers, spare light bulbs and aircraft document pouches may be omitted. The items, or reasonable facsimile, if required by the training programme, should still be available but may be relocated to a suitable location as near as practical to the original position; otherwise they may also be omitted. Fire axes and any similar purpose instruments should be omitted or be represented in silhouette or by a photograph or a similar technique.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	G	R1	R	S	COMMENTS
	<u>Window replication</u>: Windows and chin windows, if any, should be included. The glazing should provide the reflection effects for the simulated helicopter, e.g. instrument reflections in night flight conditions, mirroring effects. As applicable, equipment for operation of the cockpit windows should be included but the actual windows need not be operable. Chin windows, if present in the helicopter cockpit, should be replicated. Any window accessories and other helicopter parts visible within the visual field of view, e.g. wipers, demisting wiring, pitot tubes, handles, wire-cutters, should be replicated. A non-functional replica is acceptable and, in some cases, a silhouette may also be acceptable.				✓	<u>Instruments, panels and cockpit equipment</u>: The use of electronically displayed images with physical overlay or masking for FSTD instruments and/or instrument panels is acceptable, provided: – all instruments and instrument panel layouts are dimensionally correct with differences, if any, being imperceptible to the pilot; – instruments replicate those of the helicopter including full instrument functionality and embedded logic, if any; – instruments displayed are free of quantization (stepping); – instrument display characteristics replicate those of the helicopter including: resolution, colours, luminance, fonts, fill patterns, line styles and symbology. The brightness should correspond to the appropriate lighting control setting; the maximum brightness should be tuned to the simulator lighting conditions;
	<u>Enclosure</u>: The cockpit, including any fitted instructor's station or observer seat, should be fully enclosed. (ctd on next page)				✓	– overlay or masking, including bezels and bugs, as applicable, replicates the helicopter panel(s); – instrument controls and switches replicate and operate with the same technique, effort, travel and in the same direction as those in the helicopter; – instrument lighting should replicate that of the helicopter; it should be operated from the same control (e.g. lighting panel) as in the helicopter; the logic of operation, e.g. the type of illumination dimmed with one specific button, should be as per the helicopter;

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	G	R1	R	S	COMMENTS
						– as applicable, instruments should have faceplates that replicate those in the helicopter; – for three-dimensional instruments, such as an electro-mechanical instrument, the display image should appear to have the same: – perceived three-dimensional depth as the replicated instrument. The appearance of the simulated instrument, when viewed from any angle, should replicate that of the actual helicopter instrument. Any instrument reading inaccuracy due to viewing angle and parallax present in the actual helicopter instrument should be duplicated in the simulated instrument display image; and – typical vibrations as the instrument in the helicopter. The effects of vibration may be replicated by an animation of the displayed instrument image as long as there is no perceptible difference with the helicopter being simulated. <u>Circuit breakers</u>: All cockpit circuit breakers should replicate those in, and be located as in, the helicopter. Circuit breakers that affect procedures and/or result in observable cockpit indications should be functionally accurate. The tactile feel, technique, effort and direction required to manipulate the circuit breakers should replicate those in the helicopter.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	G	R1	R	S	COMMENTS
1.1.1.R	<u>Cockpit (simulated area)</u>: An enclosed or perceived to be enclosed, spatially representative cockpit representing a group of helicopters and the configuration (including instrument panel layout) being simulated including representative: structure bulkheads and panels; primary and secondary flight controls; engine and rotor controls; circuit breakers; flight instruments; navigation, communications and similar use equipment; caution and warning systems; and all other equipment and systems with associated controls and observable cockpit indicators sufficient for the training events to be accomplished.			✓		<u>Cockpit (simulated area)</u>: For FSTD purposes, the cockpit consists of all that space forward of a cross section of the cockpit at the most extreme aft setting of the flight crew members' seats or, if applicable, forward of that cross section immediately aft of additional crew member seats and/or required bulkheads. If the FSTD is used for VFR training, it should be a representation of the group of helicopters and of the configuration (including instrument panel and glare shield layout) comparable to the actual helicopter used for flight training.
	<u>Instruments, panels and cockpit equipment</u>: The preceding should be properly located, functionally accurate and the technique, effort and direction required to manipulate them within the correct range of movement, as applicable, should be representative of those in the group of helicopters.			✓		<u>Instruments, panels and cockpit equipment</u>: The use of electronically displayed images with physical overlay or masking for FSTD instruments and/or instrument panels is acceptable provided it incorporates operable controls representative of those in the helicopter. The instruments displayed should be free of quantization (stepping).
	<u>Window replication</u>: Windows and chin windows, if any, should be included. Window accessories may be omitted.			✓		<u>Circuit breakers</u>: A representative circuit breaker panel(s) should be presented (photographic reproductions are acceptable) and located in a spatially representative location(s). Only those circuit breakers used in a normal, abnormal or emergency procedure need to be simulated, in a group representative form, and be functionally accurate.
	<u>Enclosure</u>: The cockpit enclosure needs only to be representative of that in the group of helicopters being simulated. The enclosure needs only to extend to the aft end of the cockpit and does not need to enclose the instructor station.			✓		<u>Enclosure</u>: With the requirement for only a spatially representative cockpit, the physical dimensions of the enclosure may be acceptable to simulate more than one group of helicopters in a convertible FSTD. Each FSTD conversion should be representative of the group of helicopters being simulated which may require some controls, instruments, panels, masking, etc. to be changed for some conversions.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	G	R1	R	S	COMMENTS
1.1.1.G	<u>Cockpit (simulated area)</u>: An open, enclosed or perceived to be enclosed cockpit area with helicopter-like primary and secondary flight controls, engine and rotor controls, equipment, systems, instruments, panels and associated controls sufficient for the training tasks to be accomplished, assembled in a spatially representative manner resembling that of the group of helicopters being simulated. The flight instrument panel(s) position and crew member seats should provide the crew member(s) with a representative posture at the controls and representative design eye position.	✓				<u>Cockpit (simulated area)</u>: If the FSTD is used for any VFR training credit, it should be fitted with a representation of a glare shield that provides the crew member(s) with a representative design eye position comparable to that of the actual helicopter used for training. <u>Instruments, panels and cockpit equipment</u>: The assembled components should be compatible and function in a cohesive manner. The use of electronically displayed images with or without physical overlay or masking is acceptable. Operable controls should be incorporated if pilot input is required during training events. The instruments displayed should be free of quantization (stepping).
	<u>Enclosure</u>: An open, enclosed or perceived to be enclosed cockpit area, excluding distraction, which should be helicopter-like representative of a group of helicopters. The enclosure, if any, does not need to enclose the instructor station.	✓				"Helicopter-like" controls, instruments and equipment means as for the group of helicopters being simulated. If the FSTD is convertible, some may have to be changed for some conversions. <u>Touch screen panels</u>: For CRM training touch screen areas operated by both crew members should be capable of recognizing multiple contacts (multi touch technology) in order to enable the crew to work simultaneously, e.g. on an inter-seat console or overhead area. <u>Circuit breakers</u>: Only those circuit breakers used in a normal, abnormal or emergency procedure need to be presented, simulated in a helicopter-like form, and be functionally accurate.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	G	R1	R	S	COMMENTS
1.2	SEATING					
1.2.1	Flight crew members seating					
1.2.1.S	Flight crew member seats should replicate those in the helicopter being simulated.				✓	Helicopter cockpit observer seats are not considered to be additional flight crew member duty stations and may be omitted.
1.2.1.R	All flight crew member seats should represent those in the helicopter being simulated. They should afford the capability for the occupants to be able to achieve the design eye reference position established for the group of helicopters being simulated.			✓		Helicopter cockpit observer seats are not considered to be additional flight crew member duty stations and may be omitted.
1.2.1.G	Flight crew member seats should provide the crew member(s) with a representative design eye position and have sufficient adjustment to allow the occupant to achieve proper posture at the controls as appropriate for the group of helicopters.	✓				Helicopter cockpit observer seats are not considered to be additional flight crew member duty stations and may be omitted.
1.2.2	Instructors and observers seating					
1.2.2.S	In addition to the flight crew member seats, there should be one instructor station seat and two suitable seats for an observer and an authority inspector either located on board or off board. When located onboard, the location of the IOS seat and at least one of the observer seats should provide an adequate view of the pilots' panels and OTW forward view. When located off board, the instructor should be able to monitor the crew, crew actions and instrument indications, and he should be provided with a reasonable representation of an OTW view related to the crew's view out of the cockpit.				✓	The instructor and observers seats need not represent those found in the helicopter. All three seats should be of adequate comfort for the occupant to remain seated for a two-hour training session. For an FSTD with a motion cueing system, any on board instructor/observer seat(s) should be adequately secured and fitted with positive restraint devices of sufficient integrity to safely restrain the occupant during any known or predicted motion system excursion. Both observer seats should have adequate lighting to permit note taking and a system to permit selective monitoring of all flight crew member and instructor communications.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	G	R1	R	S	COMMENTS
	When located off board, both observer seats should be provided with appropriate means for visual and audio monitoring of the training session (crew and instructor) as well as with the possibility to take notes. At least one of the seats should be provided with a reasonable representation of an OTW view related to the crew's view out of the cockpit.					The "reasonable representation of an OTW view related to the crew's view out of the cockpit" for the observer may be the same representation as for the instructor provided that the observer has an adequate OTW view without interfering with nor distracting the instructor. The Authority may consider options to this requirement based on unique cockpit configurations or training requirements.
1.2.2.R	In addition to the flight crew member seats, there should be one instructor station seat and two suitable seats for an observer and an authority inspector.			✓		These seats need not be a replica of an aircraft seat and may be as simple as an office chair placed in an appropriate position.
1.2.2.G	In addition to the flight crew member seats, there should be one instructor station seat and two suitable seats for an observer and an authority inspector.	✓				These seats need not be a replica of an aircraft seat and may be as simple as an office chair placed in an appropriate position.
1.3	LIGHTING					
1.3.1	COCKPIT LIGHTING					
1.3.1.S	Cockpit lighting should replicate that in the helicopter.				✓	A subjective test is required.
1.3.1.R	Lighting environment for panels and instruments should be sufficient for the intended use.			✓		Back-lighted panels and instruments may be installed but are not required.
1.3.1.G	Lighting environment for panels and instruments should be sufficient for the intended use.	✓				Back-lighted panels and instruments may be installed but are not required.
1.3.1	AMBIENT LIGHTING					
1.3.2.S	Cockpit ambient lighting environment should be dynamically consistent with the visual display and sufficient for the intended use.				✓	The ambient lighting should provide an even level of illumination which is not distracting to the flight crew member(s). A subjective test is required.

	FEATURE TECHNICAL REQUIREMENT COCKPIT LAYOUT AND STRUCTURE	G	R1	R	S	COMMENTS
1.3.2.R	The ambient lighting should provide an even level of illumination that is not distracting to the flight crew member(s).			✓		A subjective test is required.
1.3.2.G	No special requirements for an ambient lighting, but the readability of the instruments should be ensured in all training situations.	✓				A subjective test is required.

2. REQUIREMENT — FLIGHT MODEL

2.	FEATURE GENERAL REQUIREMENT FLIGHT MODEL	G	R1	R	S	COMMENTS
2.S	Aerodynamic and engine modelling for the helicopter being simulated, hovering IGE and OGE, including the effects of change in helicopter attitude, sideslip, altitude, temperature, gross mass, centre of gravity location and configuration to support the intended use.				✓	Effect of aerodynamic changes for various combinations of airspeed and power normally encountered in flight, including the effect of change in helicopter attitude, aerodynamic and propulsive forces and moments, relative wind, altitude, temperature, mass, centre of gravity location and configuration. Aerodynamic modelling which includes ground effect, effects of airframe and rotor icing (if applicable), aerodynamic interference effects between the rotor wake and fuselage, influence of the rotor on control and stabilization systems, and representations of non-linearities due to sideslip, vortex ring [settling with power] and retreating blade stall.
2.R	Aerodynamic and engine modelling should be representative of the appropriate group of helicopters according to design characteristics that affect the aerodynamic model.			✓		It includes rotor design and configuration (teetering head, semi rigid, fully articulated and appropriate rotor direction of rotation), centre of gravity location, mass, altitude and temperature to include vortex ring [settling with power] and retreating blade stall.
2.G	Generic flight/engine model of a group of helicopters to support the intended use. This should include effects in the change of gross mass and centre of gravity.	✓				It includes ground effect, translational lift and the differentiation between turbine and reciprocating engines.

	FEATURE TECHNICAL REQUIREMENT FLIGHT MODEL	G	R1	R	S	COMMENTS
2.1	FLIGHT DYNAMICS MODEL					
2.1.S	A flight dynamics model, including aerodynamic and engine modelling, that accounts for various combinations of airspeed and power normally encountered in flight including the effect of change in helicopter attitude, aerodynamic and rotor forces and moments, altitude, temperature, mass, centre of gravity location and configuration.				✓	
2.1.R	A flight dynamics model, including aerodynamic and engine modelling, that accounts for various combinations of airspeed and power normally encountered in flight including the effect of change in helicopter attitude, altitude, temperature, mass, centre of gravity location and configuration.			✓		
2.1.G	A flight dynamics model helicopter-like (may be generic), including aerodynamic and engine modelling, that accounts for various combinations of airspeed and power normally encountered in flight including the effect of change in helicopter attitude, altitude, temperature, mass, centre of gravity location and configuration.	✓				
2.2	AERODYNAMICS MODEL					For anti-icing see also paragraph 4.4 of this Appendix.
2.2.S.a	Aerodynamics modelling that includes ground effect derived from type-specific flight test data. Applicable areas include flare and touchdown from a running landing as well as from IGE hover. An acceptable simulation of ground effect includes modelling of rotor efficiency, airframe drag, pitching moment, trim and power while in ground effect, and transition effect from IGE to OGE conditions and vice-versa.				✓	Validation flight test data should be used as the basis for flight and performance characteristics.

	FEATURE TECHNICAL REQUIREMENT FLIGHT MODEL	G	R1	R	S	COMMENTS
2.2.S.b	Aerodynamics modelling that includes the effects of icing, if applicable, on the airframe, the rotor aerodynamics and the engine. Icing models should simulate the aerodynamic degradation effects of ice accretion on the rotor lifting surfaces including loss of efficiency, effect on power setting, change in pitching, rolling moments, decrease in control effectiveness, and changes in control forces in addition to any overall increase in drag or helicopter gross mass with resulting effects on power.				✓	
2.2.S.c	Aerodynamics modelling that includes the effects of interference between the rotor wake and fuselage, influence of the rotor on control and stabilization systems, and representations of non-linearities due to sideslip, vortex ring [settling with power] and retreating blade stall.				✓	
2.2.R	Aerodynamics modelling, helicopter-like, derived from and appropriate to a group of helicopters to support the intended use and including ground effect, effects of airframe and rotor icing (if applicable), aerodynamic interference effects between the rotor wake and fuselage, influence of the rotor on control and stabilization systems, and representations of non-linearities due to sideslip, vortex ring [settling with power] and retreating blade stall.			✓		Validation flight test data, tailored to the representation of the group of helicopters should be used as the basis for flight and performance characteristics.
2.2.G	Generic aerodynamics modelling, helicopter-like, to support the intended use, that may include ground effect, aerodynamic interference effects between the rotor wake and fuselage, influence of the rotor on control and stabilization systems, and representations of non-linearities due to sideslip.	✓				Aerodynamic data do not need to be necessarily based on flight test data.

	FEATURE TECHNICAL REQUIREMENT FLIGHT MODEL	G	R1	R	S	COMMENTS
2.3	MASS PROPERTIES					
2.3.S	A type-specific helicopter mass properties model, including mass, centre of gravity location and moments of inertia as a function of payload and fuel loading should be implemented.				✓	
2.3.R	A representative, helicopter-like, mass properties model to support the intended use and including mass, centre of gravity and moments of inertia as a function of payload and fuel loading should be implemented.			✓		
2.3.G	A generic, helicopter-like, mass properties model to support the intended use and including mass, centre of gravity and moments of inertia as a function of payload and fuel loading should be implemented.	✓				

3. REQUIREMENT — GROUND REACTION AND HANDLING CHARACTERISTICS

3.	FEATURE GENERAL REQUIREMENT GROUND REACTION AND HANDLING CHARACTERISTICS	G	R1	R	S	COMMENTS
3.S	Ground handling to include the following: • ground reaction — reaction of the helicopter upon contact with the landing surface during landing to include strut deflections, tire or skid friction, side forces, and other appropriate parameters, such as weight and speed, necessary to identify the flight condition and configuration; and • ground taxiing characteristics — control inputs to include braking, deceleration turning radius and the effects of crosswind.				✓	Brake and tire failure dynamics and decreased brake efficiency should be specific to the helicopter being simulated. Stopping and directional control forces should be representative for all environmental landing conditions. Model to include strut/skid deflection, tire/skid friction, side forces, environmental effects and other appropriate parameters. It should also include stopping and directional control forces for various landing surface conditions based on helicopter related data, for a running landing. These conditions could include wet, dry, soft and hard, and icy surfaces for normal, slope and water landings.
3.R	Representative of a group of helicopters.			✓		Representative steering/braking technique. Does not have to be type-specific.
3.G	Generic ground handling model. Helicopter-like, not specific to model, type or variant.	✓				Distinction between wheel and skid should be available.

	FEATURE TECHNICAL REQUIREMENT GROUND REACTION AND HANDLING CHARACTERISTICS	G	R1	R	S	COMMENTS
3.1	GROUND REACTION AND HANDLING CHARACTERISTICS					
3.1.S	Ground handling to include the following: • **ground reaction** — reaction of the helicopter upon contact with the landing surface during landing to include, but not be limited to, strut deflections, tire or skid friction, side forces, and other appropriate parameters, such as weight and speed, necessary to identify the flight condition and configuration; and • **ground taxiing characteristics** — control inputs to include braking, deceleration, turning radius and the effects of crosswind.				✓	An SOC is required. Tests are required.
3.1.R	Representative ground handling of a helicopter or group of helicopters, e.g. medium twin; it does not have to be type-specific and is to include the following: • **ground reaction** — reaction of the helicopter upon contact with the landing surface during landing to include, but not be limited to, strut deflections, tire or skid friction, side forces, and other appropriate parameters, such as weight and speed, necessary to identify the flight condition and configuration; and • **ground taxiing characteristics** — control inputs to include braking, deceleration, turning radius and the effects of crosswind.			✓		An SOC is required. Tests are required.
3.1.G	Generic ground reaction model and ground taxiing characteristics that are helicopter-like, but not specific to model, type or variant.	✓				

	FEATURE TECHNICAL REQUIREMENT GROUND REACTION AND HANDLING CHARACTERISTICS	G	R1	R	S	COMMENTS
3.2	LANDING SURFACE CONDITIONS					
3.2.S	Stopping and directional control forces for at least the following landing and take-off surface conditions based on helicopter related data for a running landing, if appropriate for the helicopter area of operations and helicopter configuration: 1) dry; 2) wet (soft and hard surface); 3) icy; 4) patchy wet; 5) patchy ice; and 6) slope landings.				✓	An SOC is required. Subjective tests are required.
3.2.R	Stopping and directional control forces should be representative for at least the following landing surface conditions based on helicopter related data for a running landing: 1) dry; and 2) wet.			✓		
3.2.G	Stopping and directional control forces for dry landing surface conditions.	✓				

	FEATURE TECHNICAL REQUIREMENT GROUND REACTION AND HANDLING CHARACTERISTICS	G	R1	R	S	COMMENTS
3.3	BRAKE AND TIRE FAILURES					
3.3.S	Brake and tire failure dynamics and decreased braking efficiency due to brake temperature, if applicable.				✓	An SOC is required.
3.3.R	N/A.					
3.3.G	N/A.					

4. REQUIREMENT — HELICOPTER SYSTEMS (ATA)

4.	FEATURE GENERAL REQUIREMENT HELICOPTER SYSTEMS	G	R1	R	S	COMMENTS
4.S	Helicopter systems should be type-specific and operative to the extent that normal and, where applicable, emergency and abnormal operating procedures appropriate to the training task can be accomplished. Once activated, correct system operation should result from system management by the flight crew and not require input from the instructor's controls.				✓	To include communications, navigation, caution and warning equipment (including audio warnings and other aural cues fed through headsets) corresponding to the helicopter. Circuit breakers required for operations should be functional. To include EVS, night vision goggles if required to support the intended use. The simulator should have controls that enable the instructor/evaluator to control all required system variables and insert all abnormal or emergency conditions into the simulated helicopter systems as described in an approved training programme, or as described in the relevant operating manual as appropriate.
4.R	Helicopter systems should be representative of a group of helicopters and replicated with sufficient functionality for flight crew operation to support the intended use.			✓		To include communications, navigation, caution and warning equipment (including audio warnings and other aural cues fed through headsets). System functionality should enable sufficient normal and, where applicable, emergency and abnormal operating procedures to be accomplished. The simulator should have controls that enable the instructor/evaluator to control all required system variables and insert all abnormal or emergency conditions into the simulated helicopter systems as described in an approved training programme, or as described in the relevant operating manual as appropriate.

4.	FEATURE GENERAL REQUIREMENT HELICOPTER SYSTEMS	G	R1	R	S	COMMENTS
4.G	Helicopter systems should be helicopter-like, not specific to model, type or variant, and should be replicated with sufficient functionality for flight crew operation to support the intended use.	✓				To include communications equipment and aural cues fed through headsets, to support the intended use. System functionality should enable appropriate generic operating procedures to be accomplished, and should also allow the simulation of malfunctions, including instrument malfunctions.

	FEATURE TECHNICAL REQUIREMENT HELICOPTER SYSTEMS	G	R1	R	S	COMMENTS
4.1	NORMAL, ABNORMAL AND EMERGENCY SYSTEMS OPERATION					
4.1.S	All helicopter systems represented in the FSTD should simulate the specific helicopter type systems operation including system interdependencies, both on the ground and in flight. Systems should be operative to the extent that all normal, abnormal and emergency operating procedures can be accomplished. NVG and EVS systems should be emulated when they are represented in the helicopter or when they form part of the intended training curriculum.				✓	Helicopter system operation should be predicated on, and traceable to, the system data supplied by the helicopter manufacturer, original equipment manufacturer or alternative approved data for the helicopter system or component such as the operations manual of the system. Once activated, proper systems operation should result from system management by the crew member and not require any further input from the instructor's controls.
4.1.R	Helicopter systems represented in the FSTD should simulate representative systems operation of a helicopter or group of helicopters including system interdependencies, both on the ground and in flight. Systems should be operative to the extent that applicable normal, abnormal, and emergency operating procedures included in the operator's training programmes can be accomplished.			✓		Helicopter system operation should be predicated on, and traceable to, the system data supplied by the helicopter manufacturer, original equipment manufacturer or alternative approved data for the helicopter system or component, e.g. medium twin engine helicopter; it does not have to be type-specific. Once activated, proper systems operation should result from system management by the crew member and not require any further input from the instructor's controls.
4.1.G	The systems should be operative to the extent that it should be possible to perform normal, abnormal, and emergency operations as required for the approved training programme.	✓				Once activated, proper systems operations should result from the system management by the crew member and not require any further input from the instructor's controls.

	FEATURE TECHNICAL REQUIREMENT HELICOPTER SYSTEMS	G	R1	R	S	COMMENTS
4.2	INSTRUMENT INDICATIONS					
4.2.S	All relevant instrument indications involved in the simulation of the helicopter should automatically respond to attitude changes of the helicopter, pilot inputs or changes in system status, as well as to any external stimulus relevant for the instrument or indication being simulated. This includes but is not limited to atmospheric disturbance, effects resulting from icing, radio signals such as radionavigation or GPS or any other source.				✓	Numerical values should be presented in the appropriate units.
4.2.R	All relevant instrument indications involved in the helicopter or group of helicopters being simulated should automatically respond to attitude changes of the helicopter, pilot inputs or changes in system status, as well as to atmospheric disturbance and also respond to effects resulting from icing.			✓		Numerical values should be presented in the appropriate units.
4.2.G	All relevant instrument indications involved in the helicopter or group of helicopters being simulated should automatically respond to attitude changes of the helicopter, pilot inputs or changes in system status.	✓				
4.3	COMMUNICATIONS, NAVIGATION, CAUTION AND WARNING SYSTEMS					
4.3.S	Communications, navigation, caution and warning equipment, including audio warnings and other aural cues fed through headsets, corresponding to that installed in a specific helicopter type should operate within the tolerances and operation characteristics prescribed for the applicable airborne equipment.				✓	Operation characteristics include any specific behaviour of the equipment being simulated, e.g. dependencies between two or more simulated systems in case of malfunctions or special operating limitations of general purpose equipment resulting from the integration in the helicopter type being simulated.

	FEATURE TECHNICAL REQUIREMENT HELICOPTER SYSTEMS	G	R1	R	S	COMMENTS
4.3.R	Communications, navigation, caution and warning equipment, including audio warnings and other aural cues fed through headsets, corresponding to that typically installed in a representative helicopter simulation should operate within the tolerances prescribed for the applicable airborne equipment.			✓		
4.3.G	Communications equipment and aural cues fed through headsets, to support the intended use.	✓				
4.4	ANTI-ICING SYSTEMS					For flight model icing effects see also paragraph 2.2 of this Appendix.
4.4.S	Anti-icing systems corresponding to those installed in the specific helicopter type should operate with appropriate effects upon ice formation on airframe, engines and instrument sensors.				✓	
4.4.R	Operation of anti-icing systems corresponding to those typically installed in that helicopter or group of helicopters should operate.			✓		Simplified airframe and engine, including engine induction and pitot-static system, icing models with corresponding performance degradations due to icing should be provided. Effects of anti-icing/de-icing systems activation should also be present.
4.4.G	N/A.					

5. REQUIREMENT — FLIGHT CONTROLS AND FORCES

5.	FEATURE GENERAL REQUIREMENT FLIGHT CONTROLS AND FORCES	G	R1	R	S	COMMENTS
5.S	Control forces and control travel should replicate those of the helicopter being simulated. Controls should react in the same manner as in the helicopter under the same flight conditions. Control displacement should generate the same effect as the helicopter under the same flight conditions. Control feel dynamics should replicate those of the helicopter being simulated.				✓	
5.R	Representative of a group of helicopters (e.g. pedal position with rotor direction), but it does not have to be type-specific.			✓		Active force feedback required if appropriate (i.e. not required if not present on the aircraft, e.g. in fly-by-wire aircraft).
5.G	Helicopter-like, not specific to model, type or variant (e.g. no proportional force feedback required).	✓				Active force feedback not essential.

	FEATURE TECHNICAL REQUIREMENT FLIGHT CONTROLS AND FORCES	G	R1	R	S	COMMENTS
5.1	CONTROL FORCES AND TRAVEL					Testing of position versus force is not applicable if forces are generated solely by use of helicopter hardware in the FSTD.
5.1.S	Control forces and control travel should correspond to that of the helicopter being replicated. Control forces and travel should react in the same manner and generate the same effect as in the helicopter under the same flight and system conditions.				✓	Active force feedback required if appropriate to the helicopter installation.
5.1.R	Control forces and control travel should correspond to that of the group of helicopters being simulated. Control forces and travel should react in the same manner and generate the same effect as in the group of helicopters under the same flight and system conditions.			✓		Active force feedback required if appropriate to the helicopter installation.
5.1.G	Control forces and control travel and resulting effect should broadly correspond to the group of helicopters being simulated.	✓				Active force feedback not required. Control forces produced by a passive arrangement are acceptable.
5.2	CONTROL FEEL DYNAMICS					
5.2.S	Control feel dynamics should replicate the helicopter being simulated.				✓	See Part II, Appendix B, paragraph 3.2 for a discussion of acceptable methods of validating control dynamics. See Part III, Appendix B, tests 2.a.5 (control dynamics) for the required tests.
5.2.R	N/A.					
5.2.G	N/A.					
5.3	CONTROL SYSTEM OPERATION					
5.3.S	Control systems should replicate helicopter operation for the normal and any non-normal modes including back-up systems and should reflect failures of associated systems. Appropriate cockpit indications and messages should be replicated.				✓	See Part III, Appendix C for applicable testing.

	FEATURE TECHNICAL REQUIREMENT FLIGHT CONTROLS AND FORCES	G	R1	R	S	COMMENTS
5.3.R	Control systems should replicate the group of helicopters operation for the normal and any non-normal modes including back-up systems and should reflect failures of associated systems. Appropriate cockpit indications and messages should be replicated.			✓		See Part III, Appendix C for applicable testing.
5.3.G	Control systems should allow basic helicopter operation with appropriate cockpit indications.	✓				See Part III, Appendix C for applicable testing.

6. REQUIREMENT — SOUND CUES

6.	FEATURE GENERAL REQUIREMENT SOUND CUES	G	R1	R	S	COMMENTS
6.S	N/A.					
6.R	Realistic sound cues appropriate to the specific helicopter being simulated. Significant sounds perceptible to the flight crew during flight operations to support the intended use.			✓		Variable N_R (overspeed/underspeed), engine noise (e.g. compressor stall, surge), blade slap specific to target rotor system. The volume control should have an indication of sound level setting. Correlation with helicopter systems simulation and motion/vibration platform (when installed) should be ensured.
6.G	Helicopter-like, but not specific to model, type or variant.	✓				Variable N_R, engine noise, blade slap. The volume control should have an indication of sound level setting. See helicopter ATA-systems specific audio covered separately in paragraph 4 of this Appendix.

	FEATURE TECHNICAL REQUIREMENT SOUND CUES	G	R1	R	S	COMMENTS
6.1	SOUND SYSTEM					
6.1.R	Significant cockpit sounds during normal and abnormal operations corresponding to those of the helicopter, including engine, transmission, rotor and aircraft systems sounds as well as those which result from pilot- or instructor-induced actions.			✓		Sounds as a function of flight conditions: variable N_R, engine noise, blade slap, etc. Aircraft systems refers to components generating sound audible to the flight crew, such as pumps, motors, fans, vents air flow and wipers. An SOC is required. Tests are required. See Part III, Appendix B.
6.1.G	Sounds due to engine(s), transmission(s) and rotor(s) should be available, helicopter-like, but not specific to model, type or variant.	✓				Sounds as a function of flight conditions: variable N_R, engine noise, blade slap. Engine type (piston versus turbine) should be differentiated. An SOC is required.
6.2	CRASH SOUNDS					
6.2.R	The sound of a crash when the simulated helicopter exceeds limitations.			✓		
6.2.G	The sound of a crash when the simulated helicopter exceeds limitations.	✓				
6.3	ENVIRONMENTAL SOUNDS					
6.3.R	Significant environmental sounds should be coordinated with the simulated weather.			✓		
6.3.G	Environmental sounds are not required. However, if present, they should be coordinated with the simulated weather.	✓				

	FEATURE TECHNICAL REQUIREMENT SOUND CUES	G	R1	R	S	COMMENTS
6.4	SOUND VOLUME					
6.4.R	The volume control should have an indication of sound level setting which meets all qualification requirements. Full volume should correspond to actual volume levels in the approved data set. When full volume is not selected, an indication of abnormal setting should be provided to the instructor.			✓		The indication of abnormal setting should consist of an annunciation on a main IOS page which is always visible to the instructor.
6.4.G	The volume control should have an indication of sound level setting which meets all qualification requirements. Full volume should correspond to actual volume level agreed at the initial evaluation. When full volume is not selected, an indication of abnormal setting should be provided to the instructor.	✓				
6.5	SOUND DIRECTIONALITY					
6.5.R	Sound should be directionally representative.			✓		Although most steady state sounds originate above and behind, some specific sounds (e.g. skids impact during an asymmetric touchdown, windshield wipers) should be directionally differentiated. An SOC is required.
6.5.G	Sound not required to be directional.	✓				

7. REQUIREMENT — VISUAL DISPLAY CUES

7.	FEATURE GENERAL REQUIREMENT VISUAL DISPLAY CUES	G	R1	R	S	COMMENTS
7.S	Continuous field of view specific to the helicopter being simulated from the handling pilot's normal eyepoint with detailed close-up perspective and textured representation of all ambient conditions for each pilot, to support the intended use. Visual cues to assess the rate of change of height, height AGL and translational displacements and rates, during take-off, low altitude/low airspeed manoeuvring, hover, and landing. Field of view: minimum field of view of 210 degrees horizontal by 60 degrees vertical. The vertical eyepoint reference is adjusted approximately 1/3 up and 2/3 down. Visual fidelity: the visual scene displays an identifiable horizon in day and night VFR conditions suitable for determining the helicopter attitude in the pitch, roll and yaw axes. The system should be capable of displaying contoured terrain at the resolution demanded by the environment. Landing area(s) provided should be visible from a distance sufficient to allow the pilot to establish, stabilize and maintain approach angles up to 45 degrees from 300 m (1 000 ft) AGL to the surface unless obstructed by the cockpit structure. Focus and clarity of terrain and ground objects should be sharp.				✓	Field of view in the training device replicates the helicopter field of view without obstruction. Where appropriate for the training task(s), an extended FOV including chin windows should be provided. These tasks may include take-offs, departures, approaches and landings in confined areas, on sloping ground, in snow/sand/etc., on a rig or a ship, etc.

7.	FEATURE GENERAL REQUIREMENT VISUAL DISPLAY CUES	G	R1	R	S	COMMENTS
7.R	Visual cues to assess the rate of change of height and translational displacements and rates, during take-off and landing. Field of view: minimum field of view of 180 degrees horizontal by 45 degrees vertical. The vertical eyepoint reference is adjusted 1/3 up and 2/3 down. Visual fidelity: the visual scene displays an identifiable horizon in day and night VFR conditions suitable for determining the helicopter attitude in the pitch, roll, and yaw axes. Landing area(s) provided should be visible from a distance sufficient to allow the pilot to establish, stabilize and maintain approach angles up to 20 degrees from 300 m (1 000 ft) AGL to the surface unless obstructed by the cockpit structure. Focus and clarity of terrain and ground objects should be sharp.			✓		
7.G	Field of view: minimum 45 degrees horizontal by 30 degrees vertical. Daylight, dusk or dawn, and night visual scenes adequate for instrument training with the capability to display sufficient scene content to recognize generic aerodromes, heliports, terrain and landmarks around the final approach and take-off (FATO) area and to successfully accomplish low airspeed/low altitude manoeuvres to include lift-off, hover, translational lift, landing and touchdown. (ctd on next page)	✓				

7.	FEATURE GENERAL REQUIREMENT VISUAL DISPLAY CUES	G	R1	R	S	COMMENTS
	Visual fidelity: the visual scene displays an identifiable horizon in day and night VFR conditions suitable for determining the helicopter attitude in the pitch and roll axes. If a landing area is provided, it must be visible from a distance sufficient to allow the pilot to establish, stabilize and maintain a shallow approach angle (less than 5 degrees) from 300 m (1 000 ft) AGL to the surface unless obstructed by the cockpit structure.					

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	G	R1	R	S	COMMENTS
7.1	DISPLAY					The choice of the display system and of the field of view requirements should fully consider the intended use of the FSTD. The balance between training and testing/checking may influence the choice and geometry of the display system. In addition the diverse operational requirements should be addressed. Guidance on display types is provided in Attachment R to Part II.
7.1.S	Continuous FOV of at least 210° horizontally and 60° vertically FOV for each pilot simultaneously. The image should be aligned to the pilot flying. The misalignment observed by the non-flying pilot should not exceed 20 degrees. The vertical FOV should be distributed such that 20 degrees is above the horizon and 40 degrees is below. Where the rotor blade tip path would be visible in the helicopter from the pilot eyepoint, it should be appropriately depicted. The system should be free from optical discontinuities and artefacts that create non-realistic cues.				✓	The horizontal and vertical FOV distribution may be adjusted to cover the particular helicopter configuration. An SOC is required and should explain the geometry of the installation. See Part III, Appendix B (test 4.a.1, field of view). Joins in the display surface are allowed where required for transportation of mobile simulators, but should be minimized.
7.1.R	Continuous FOV of at least 180° horizontally and 45° vertically for each pilot simultaneously. The image should be aligned to the pilot flying. The misalignment observed by the non-flying pilot should not exceed 20 degrees. (ctd on next page)			✓		Horizontal and vertical FOV distribution may be adjusted to cover the particular helicopter configuration. An SOC is required and should explain the geometry of the installation. See Part III, Appendix B (test 4.a.1, field of view).

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	G	R1	R	S	COMMENTS
	The vertical FOV should be distributed such that 15 degrees is above the horizon and 30 degrees is below. Where the rotor blade tip path would be visible within the above FOV, it should be appropriately depicted. The system should be free from optical discontinuities and artefacts that create non-realistic cues.					Joins in the display surface are allowed where required for transportation of mobile simulators, but should be minimized.
7.1.G	An FOV of at least 45° horizontally and 30° vertically for each pilot simultaneously. The image should be aligned to the pilot flying. The misalignment observed by the non-flying pilot should not exceed 20 degrees. Where the rotor blade tip path would be visible within the above FOV, it should be appropriately depicted. The minimum distance from the pilot's eye position to the surface of a direct view display may not be less than the distance to any front panel instrument.	✓				The horizontal and vertical FOV distribution may be adjusted to cover the particular helicopter configuration. See Part III, Appendix B (test 4.a.1, field of view).
7.2	SURFACE RESOLUTION					
7.2.S	Surface resolution demonstrated by a test pattern of objects shown to occupy a visual angle of not greater than 2 arc minutes in the visual display used on a scene from the pilot's eyepoint.				✓	An SOC is required containing calculations confirming the resolution. See Part III, Appendix B (test 4.a.3, surface resolution).
7.2.R	Surface resolution demonstrated by a test pattern of objects shown to occupy a visual angle of not greater than 3 arc minutes in the visual display used on a scene from the pilot's eyepoint.			✓		An SOC is required containing calculations confirming the resolution. See Part III, Appendix B (test 4.a.3, surface resolution).

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	G	R1	R	S	COMMENTS
7.2.G	Surface resolution demonstrated by a test pattern of objects shown to occupy a visual angle of not greater than 4 arc minutes in the visual display used on a scene from the pilot's eyepoint.	✓				An SOC is required containing calculations confirming the resolution. See Part III, Appendix B (test 4.a.3, surface resolution).
7.3	LIGHT-POINT SIZE					
7.3.S	Light-point size — not greater than 5 arc minutes.				✓	An SOC is required confirming that the test pattern represents lights used for airfield lighting. See Part III, Appendix B (test 4.a.4, light-point size).
7.3.R	Light-point size — not greater than 8 arc minutes.			✓		An SOC is required confirming that the test pattern represents lights used for airfield lighting. See Part III, Appendix B (test 4.a.4, light-point size).
7.3.G	Light-point size — not greater than 8 arc minutes.	✓				An SOC is required confirming that the test pattern represents lights used for airfield lighting. See Part III, Appendix B (test 4.a.4, light-point size).
7.4	SURFACE CONTRAST RATIO					
7.4.S	Surface contrast ratio adequate to clearly identify image features — not less than 8:1.				✓	See Part III, Appendix B (test 4.a.5, surface contrast ratio).
7.4.R	Surface contrast ratio adequate to identify surface features — not less than 5:1.			✓		See Part III, Appendix B (test 4.a.5, surface contrast ratio).
7.4.G	Surface contrast ratio adequate for the intended use — not less than 4:1.	✓				See Part III, Appendix B (test 4.a.5, surface contrast ratio).
7.5	LIGHT-POINT CONTRAST RATIO					
7.5.S	Light-point contrast ratio sufficient to clearly identify illumination sources and light — not less than 25:1.				✓	See Part III, Appendix B (test 4.a.6, light-point contrast ratio).
7.5.R	Light-point contrast ratio sufficient to identify light — not less than 10:1.			✓		See Part III, Appendix B (test 4.a.6, light-point contrast ratio).
7.5.G	Light-point contrast ratio sufficient to identify lights — not less than 8:1.	✓				See Part III, Appendix B (test 4.a.6, light-point contrast ratio).

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	G	R1	R	S	COMMENTS
7.6	SYSTEM BRIGHTNESS					
7.6.S	System brightness should be demonstrated using a raster drawn test pattern, be sufficient to appear like an average day and maintain contrast ratio. The surface brightness should not be less than 20 cd/m^2 (5.8 ft-lamberts).				✓	See Part III, Appendix B (test 4.a.8, surface brightness).
7.6.R	System brightness should be demonstrated using a raster drawn test pattern, be sufficient to appear like an average day and maintain contrast ratio. The surface brightness should not be less than 14 cd/m^2 (4.1 ft-lamberts).			✓		See Part III, Appendix B (test 4.a.8, surface brightness).
7.6.G	Sufficient to support the intended use.	✓				
7.7	BLACK LEVEL AND SEQUENTIAL CONTRAST					An explanation should be provided in cases where the test is not considered relevant to the display type.
7.7.S	The black level and sequential contrast need to be measured to determine that they are sufficient for training in all times of day.				✓	See Part III, Appendix B (test 4.a.9, black level and sequential contrast).
7.7.R	The black level and sequential contrast need to be measured to determine that they are sufficient for training in all times of day.			✓		
7.7.G	Suitable to support the intended use.	✓				
7.8	MOTION BLUR					An explanation should be provided in cases where the test is not considered relevant to the display type.
7.8.S	Tests are required to determine the amount of motion blur that is typical of certain types of display equipment. A test should be provided that demonstrates the amount of blurring at a pre-defined rate of movement across the image.				✓	See Part III, Appendix B (test 4.a.10, motion blur).
7.8.R	Suitable to support the intended use.			✓		
7.8.G	Suitable to support the intended use.	✓				

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	G	R1	R	S	COMMENTS
7.9	SPECKLE TEST					An explanation should be provided in cases where the test is not considered relevant to the display type. This test normally only applies to projectors using light sources with some degree of coherence.
7.9.S	A test is required to determine that the speckle typical of laser-based displays is below a distracting level.				✓	See Part III, Appendix B (test 4.a.11, speckle test).
7.9.R	Suitable to support the intended use.			✓		
7.9.G	Suitable to support the intended use.	✓				
7.10	HEAD-UP DISPLAY (where fitted)					Includes head mounted device or other device for displaying data overlaying the out of the window scene.
7.10.S	Display equipment should be provided as fitted in the helicopter cockpit. An active display (repeater) of all parameters displayed to the pilot should be located on the instructor operator station (IOS), or other location approved by the NAA. Display format of the repeater should represent that of the parameters displayed to the pilot.				✓	An SOC is required. For non-collimated systems, only one display can be used by the pilot flying due to alignment with the out of the window displays. See Part III, Appendix B (test 4.b, head-up display) and Attachment K to Part II.
7.10.R	Display equipment should be provided as fitted in the helicopter cockpit, or the data may be displayed on the out of the window display. An active display (repeater) of all parameters displayed to the pilot should be located on the instructor operator station (IOS), or other location approved by the NAA. Display format of the repeater should represent that of the parameters displayed to the pilot.			✓		An SOC is required. For non-collimated systems, only one display can be used by the pilot flying due to alignment with the out of the window displays. Where data are displayed outside the cockpit such as overlaid on the visual image, the data image should be controllable by the pilot as it is on the helicopter, and would only be applicable to single pilot operations. See Part III, Appendix B (test 4.b, head-up display) and Attachment K to Part II.

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	G	R1	R	S	COMMENTS
7.10.G	N/A.					
7.11	ENHANCED FLIGHT VISION SYSTEM (EFVS) (where fitted) – Including NVG					
7.11.S	The EFVS simulator hardware/software, including associated cockpit displays and annunciation, should function in the same way as, or in an equivalent manner to, the EFVS system installed in the helicopter. A minimum of one airport should be modelled for EFVS operation. The model should include an ILS and a non-precision approach (with VNAV if required for that helicopter type). Where a HUD image is used it (image and symbology) should be repeated as per the HUD requirement in 7.10.S of this Appendix. IOS weather presets should be provided for EFVS minimums.				✓	For non-collimated systems, only one EFVS can be used by the pilot flying due to alignment display issues. See Part III, Appendix B (test 4.c, enhanced flight vision system) and Attachment L to Part II.
7.11.R	The EFVS simulator hardware/software, including associated cockpit displays and annunciation, should function in the same way as, or in an equivalent manner to, the EFVS system installed in the helicopter. A minimum of one airport should be modelled for EFVS operation. The model should include an ILS and a non-precision approach (with VNAV if required for that helicopter type).			✓		Only one HUD/EFVS can be used by the pilot flying due to alignment display issues. Alternatively the EFVS may be presented as an inset in the visual scene representing the typical HUD FOV. See Part III, Appendix B (test 4.c, enhanced flight vision system) and Attachment L to Part II.
7.11.G	N/A.					

	FEATURE TECHNICAL REQUIREMENT VISUAL DISPLAY CUES	G	R1	R	S	COMMENTS
7.12	VISUAL GROUND SEGMENT					
7.12.S	A test is required to demonstrate that the visibility is correct on final approach in CAT II conditions and the positioning of the helicopter is correct relative to the runway.				✓	See Part III, Appendix B (test 4.d, visual ground segment).
7.12.R	A test is required to demonstrate that the visibility is correct on final approach in CAT II conditions and the positioning of the helicopter is correct relative to the runway.			✓		See Part III, Appendix B (test 4.d, visual ground segment).
7.12.G	A demonstration of suitable visibility is required.	✓				
7.13	ROTOR DOWNWASH EFFECTS					
7.13.S	The system should provide the ability to present the effect of recirculating dust, water vapour, or snow conditions that develops as a result of rotor downwash. The effect is to be correlated with the surface type under the helicopter.				✓	
7.13.R	N/A.					
7.13.G	N/A.					

8. REQUIREMENT — VIBRATION CUES

8.	FEATURE GENERAL REQUIREMENT VIBRATION CUES	G	R1	R	S	COMMENTS
8.S	Characteristic type-specific vibrations/buffets that result from operation of the helicopter and which can be sensed in the cockpit.				✓	Cue fidelity to incorporate all those provided by R fidelity in 8.R but specific to type, plus additional cues emanating from landing gear state, main rotor and tail rotor torque loading effects, and detailed malfunction effects (to include those associated with main rotor damper, vibration suppression systems, and anti-torque bearing/coupling/gearbox/driveshaft).
8.R	Pilot receives effective and representative vibration cues.			✓		Cue fidelity to incorporate all those provided by G fidelity in 8.G, plus additional primary anti-torque system vibration cues (e.g. tail rotor, fenestron, NOTAR system), cues due to main rotor and anti-torque system blade tracking and balance effects, hydraulic system failures, icing effects, vortex ring [settling with power] state, autorotation and basic anti-torque system failure cues. Cues due to operation in the low relative speed environment (e.g. relative wind from all directions) and the high relative speed environment (e.g. retreating main rotor blade stall) should also be provided. All effects should be appropriate to a group of helicopters.
8.G	Pilot receives helicopter-like vibration cues.	✓				Fundamental helicopter vibration cues, to include primary main rotor speed and disc loading cues, translational lift and speed change cues (acceleration and deceleration), and a general abnormal vibration cue.

	FEATURE TECHNICAL REQUIREMENT VIBRATION CUES	G	R1	R	S	COMMENTS
8.1	VIBRATION CUES GENERAL					See Attachment P to Part II for guidance on vibration systems.
8.1.S	Characteristic buffet/vibration effects that result from operation of the helicopter should be present, in so far as the buffet/vibration marks an event or helicopter state that can be sensed in the cockpit. The FSTD should provide vibration and buffet effects programming to include the following: 1) primary main rotor speed and disk loading vibration effects; 2) buffet due to translational lift and effect of speed changes; 3) runway rumble, oleo deflections, effects of ground speed, uneven runway, characteristics; 4) buffets due to transverse flow effects; 5) buffet during extension and retraction of landing gear (if applicable); 6) buffet due to retreating blade stall; 7) buffet due to vortex ring (settling with power); 8) representative cues resulting from touchdown; 9) high speed rotor vibrations; 10) buffet due to tire failure dynamics; 11) buffet due to engine malfunction and damage; (ctd on next page)				✓	An SOC is required. Motion vibrations tests are required and should include recorded results that allow the comparison of relative amplitudes versus frequency. The simulator should be programmed and instrumented in such a manner that the characteristic buffet modes can be measured and compared to helicopter data for test cases detailed in tests 3bis, vibrations of Appendix B to this Part. For air turbulence, general purpose disturbance models are acceptable if, when used, they produce test results that approximate demonstrable flight test data.

	FEATURE TECHNICAL REQUIREMENT VIBRATION CUES	G	R1	R	S	COMMENTS
	12) buffet due to airframe ground contact; 13) vibration that results from atmospheric disturbances; and 14) vibration due to icing effect. And any vibration/buffet effect characteristic of rotor and transmission system of the simulated helicopter type.					
8.1.R	The FSTD should provide vibration and buffet effects programming to include the following: 1) primary main rotor speed and disk loading vibration effects; 2) buffet due to translational lift and effect of speed changes; 3) buffets due to transverse flow effects; 4) buffet due to retreating blade stall; 5) buffet due to vortex ring (settling with power); 6) high speed rotor vibrations; 7) buffet due to engine malfunction and damage; 8) buffet due to airframe ground contact; 9) vibration that results from atmospheric disturbances; and 10) vibration due to icing effect.			✓		Motion vibrations tests are required and should include recorded results that allow the comparison of relative amplitudes versus frequency. The simulator should be programmed and instrumented in such a manner that the characteristic buffet modes can be measured using a footprint principle data for the test cases detailed in tests 3bis (vibrations) of Part III, Appendix B.

	FEATURE TECHNICAL REQUIREMENT VIBRATION CUES	G	R1	R	S	COMMENTS
8.1.G	The FSTD should have at least a vibration cueing system for characteristic helicopter vibrations noted at the pilot station(s) and should provide vibration and buffet effects programming to include the following: 1) primary main rotor speed and disk loading vibration effects; 2) buffet due to translational lift and effect of speed changes; and 3) buffets due to abnormal system conditions.	✓				

9. REQUIREMENT — MOTION CUES

9.	FEATURE GENERAL REQUIREMENT MOTION CUES	G	R1	R	S	COMMENTS
9.S	N/A.					
9.R	Pilot receives an effective and representative motion cue and stimulus, which provides the appropriate sensations of acceleration of the helicopter's 6 DOF. Motion cues should always provide the correct sensation, to support the intended use.			✓		
9.R1	Pilot receives an effective and representative motion cue and stimulus, which provides the appropriate sensations of acceleration of the helicopter's 6 DOF. Motion cues should always provide the correct sensation, to support the intended use. The sensation of motion can be less than in 9.R, the magnitude of the cues being reduced.		✓			
9.G	N/A.					

	FEATURE TECHNICAL REQUIREMENT MOTION CUES	G	R1	R	S	COMMENTS
9.1	MOTION CUES GENERAL					When motion systems have been added by the FSTD operator even though not required for that type of device for attracting specific credits, they will be assessed to ensure that they do not adversely affect the qualification of the FSTD.
9.1.R	Motion cues (force) in 6 DOF, as perceived by the pilot, should be representative of the simulated helicopter's motion in-flight and on the ground.			✓		An SOC is required. See Part III, Appendices B and C for the evaluation differences between R and R1 for this requirement.
9.1.R1	Motion cues (force) in 6 DOF, as perceived by the pilot, should be representative of the simulated helicopter's motion in-flight and on the ground.		✓			An SOC is required. See Part III, Appendices B and C for the evaluation differences between R and R1 for this requirement.
9.2	MOTION FORCE CUEING					
9.2.R	The motion (force cueing) system should produce cues perceived at the pilot reference position in 6 DOF (i.e. pitch, roll, yaw, heave, sway and surge).			✓		An SOC is required.
9.2.R1	The motion (force cueing) system should produce cues perceived at the pilot reference position in 6 DOF (i.e. pitch, roll, yaw, heave, sway and surge). The magnitude of the cues can be partially reduced and the perception of motion can be less.		✓			An SOC is required.
9.3	MOTION EFFECTS					
9.3.R	Motion effects should include characteristic buffets and bumps that result from operation of the helicopter, in so far as these mark an event or helicopter state that can be sensed in the cockpit.			✓		See Part III, Appendix C, table of functions and subjective tests (tests 13, motion and vibration effects).
9.3.R	1) Touchdown cues for main and nose gear or for skids, based on their geometry.			✓		Touchdown bumps should reflect the effects of lateral and directional cues resulting from crab or crosswind landings, as well as from rate of descent. Conduct several normal approaches with various rates of descent. Check that the motion cues for the touchdown bumps for each rate of descent are representative of the actual helicopter.

	FEATURE TECHNICAL REQUIREMENT MOTION CUES	G	R1	R	S	COMMENTS
9.3.R	2) Tire failure dynamics. Simulate a single tire failure and a multiple tire failure.			✓		The pilot may notice some yawing with a multiple tire failure selected on the same side. This should require the use of the pedal to maintain control of the helicopter. Dependent on helicopter type, a single tire failure may not be noticed by the pilot and may not cause any special motion effect. Sound or vibration may be associated with the actual tire losing pressure.
9.3.R	3) Airframe ground strike (e.g. tail and pod strike). Tail-strikes can be checked by over-rotation of the helicopter at a quick stop or autorotation to the ground.			✓		The motion effect should be felt as a noticeable nose down pitching moment.
9.3.R1	Motion effects should include characteristic buffets and bumps that result from operation of the helicopter, in so far as these mark an event or helicopter state that can be sensed in the cockpit.		✓			See Part III, Appendix C, table of functions and subjective tests (tests 13, motion and vibration effects).
9.3.R1	1) Touchdown cues for main and nose gear or for skids, based on their geometry.		✓			Touchdown bumps should reflect the effects of lateral and directional cues resulting from crab or crosswind landings, as well as from rate of descent. Conduct several normal approaches with various rates of descent. Check that the motion cues for the touchdown bumps for each rate of descent are representative of the actual helicopter.
9.3.R1	2) Tire failure dynamics. Simulate a single tire failure and a multiple tire failure.		✓			The pilot may notice some yawing with a multiple tire failure selected on the same side. This should require the use of the pedal to maintain control of the helicopter. Dependent on helicopter type, a single tire failure may not be noticed by the pilot and may not cause any special motion effect. Sound or vibration may be associated with the actual tire losing pressure.
9.3.R1	3) Airframe ground strike (e.g. tail and pod strike). Tail-strikes can be checked by over-rotation of the helicopter at a quick stop or autorotation to the ground.		✓			The motion effect should be felt as a noticeable nose down pitching moment.

10. REQUIREMENT — ENVIRONMENT — NAVIGATION

10	FEATURE GENERAL REQUIREMENT ENVIRONMENT — NAVIGATION	G	R1	R	S	COMMENTS
10.S	Navigational data with the corresponding approach facilities to support the intended use, such as GPS, VOR, DME, ILS, NDB, etc.				✓	Navigation aids should correspond to the real world and be usable within range without restriction unless intentionally reduced due to terrain or other obstructions.
10.R	N/A.					
10.G	N/A.					

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — NAVIGATION	G	R1	R	S	COMMENTS
10.1	NAVIGATION DATABASE					
10.1.S	Navigation database sufficient to support simulated helicopter systems for real world operations.				✓	
10.1.R	N/A.					
10.1.G	N/A.					
10.2	MINIMUM AIRPORT/HELIPORT REQUIREMENT					
10.2.S	Complete navigation database for at least one airport and/or heliport including regular updates.				✓	Regular updates means navigation database updates as mandated by the NAA. If GPS approaches are available at these airports or heliports, they should be supported if the helicopter is so equipped.
10.2.R	N/A.					
10.2.G	N/A.					
10.3	INSTRUCTOR CONTROLS					
10.3.S	Instructor controls of internal and external navigational aids.				✓	E.g. helicopter ILS glideslope receiver failure compared to ground facility glideslope failure.
10.3.R	N/A.					
10.3.G	N/A.					
10.4	ARRIVAL/DEPARTURE FEATURES					
10.4.S	Navigational data with all the corresponding standard arrival and departure procedures.				✓	
10.4.R	N/A.					
10.4.G	N/A.					

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — NAVIGATION	G	R1	R	S	COMMENTS
10.5	NAVIGATION AIDS RANGE					
10.5.S	Navigational data with all the corresponding standard arrival and departure procedures.				✓	Navigation aids should correspond to the real world and be usable within range without restriction unless intentionally reduced due to terrain or other obstructions.
10.5.R	N/A.					
10.5.G	N/A.					

11. REQUIREMENT — ENVIRONMENT — ATMOSPHERE AND WEATHER

11	FEATURE GENERAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER	G	R1	R	S	COMMENTS
11.S	Specific to the training task.				✓	Other atmospheric effects may include, but are not limited to, representations of: 1) arctic sea smoke; 2) katabatic winds; 3) mountain effects (rotors, demarcation lines, etc.); 4) rig exhaust turbulence; 5) wind masking due to buildings, trees, etc.; 6) turbulence and wind effects caused by topography and structures; 7) wake vortices and downwash from other aircraft; and 8) wind shear.
11.R	Fully integrated dynamic environment simulation including a representative atmosphere with weather effects to support the intended use. Environment simulation should include thunderstorms, turbulence, microbursts and appropriate types of precipitation.			✓		To include surface features (moving grass, sea surface).
11.G	Basic atmospheric model, pressure, temperature, visibility, cloud base and winds to support the intended use. The environment should be synchronized with appropriate helicopter and simulation features to provide integrity.	✓				

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER	G	R1	R	S	COMMENTS
11.1	STANDARD ATMOSPHERE					
11.1.S	Simulation of the standard atmosphere including instructor control over key parameters. Other atmospheric effects, such as arctic sea smoke, katabatic winds, etc., that are required to support the intended use should be demonstrated.				✓	
11.1. R, G	Simulation of the standard representative atmosphere including instructor control over key parameters.	✓		✓		
11.2	WIND SHEAR					
11.2.S	The FSTD should employ wind shear models that provide training for recognition of wind shear phenomena.				✓	A subjective test is required. See Part III, Appendix C, table of functions and subjective tests (test 11.b.7, wind shear/microburst encounters).
11.2.R	N/A.					
11.2.G	N/A.					
11.3	WEATHER EFFECTS					
11.3.S	Smooth transition between weather effects should be provided. The following weather effects as observed on the visual system should be simulated and respective instructor controls provided:					A subjective test is required. See Part III, Appendix C, table of functions and subjective tests (test 12.g, environmental effects). The intent of this capability is to demonstrate transition from VMC to IMC.
	1) multiple cloud layers with adjustable bases, tops, sky coverage and scud effect;				✓	
	2) storm cells activation and/or deactivation;				✓	
	3) visibility and RVR, including fog and patchy fog effects;				✓	An objective test is required. Refer to Part III, Appendix B (test 4.d, visual ground segment).
	(ctd on next page)					

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER	G	R1	R	S	COMMENTS
	4) effects of own aircraft external lighting;				✓	
	5) effects of airport or heliport lighting (including variable intensity and fog effects);				✓	
	6) surface contaminants (including wind blowing and rotor downwash/recirculation effects);				✓	
	7) variable precipitation effects (rain, hail, snow);				✓	
	8) in-cloud airspeed effect; and				✓	
	9) gradual visibility changes entering and breaking out of cloud.				✓	
11.3.R	Smooth transition between weather effects should be provided.					A subjective test is required. See Part III, Appendix C, table of functions and subjective tests (test 12.g, environmental effects).
	The following weather effects as observed on the visual system should be simulated and respective instructor controls provided:					The intent of this capability is to demonstrate transition from VMC to IMC.
	1) multiple cloud layers with adjustable bases, tops, sky coverage and scud effect;			✓		
	2) storm cells activation and/or deactivation;			✓		
	3) visibility and RVR, including fog effect;			✓		An objective test is required. Refer to Part III, Appendix B (test 4.d, visual ground segment).
	4) effects of own aircraft external lighting;			✓		
	5) surface contaminants and own aircraft downwash and recirculation effect;			✓		
	6) precipitation effects (rain, hail, snow); and			✓		
	7) gradual visibility changes entering and breaking out of cloud.			✓		

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER	G	R1	R	S	COMMENTS
11.3 G	Smooth transition between weather effects should be provided. The following weather effects as observed on the visual system should be simulated and respective instructor controls provided:					A subjective test is required. See Part III, Appendix C table of functions and subjective tests (test 12.g, environmental effects). The intent of this capability is to demonstrate transition from VMC to IMC.
	1) a cloud layer with adjustable base and top; and	✓				
	2) visibility and RVR.	✓				
11.4	INSTRUCTOR CONTROLS					
11.4.S	The following features should be simulated, with appropriate instructor controls provided:					A subjective test is required. See Part III, Appendix C, table of functions and subjective tests (test 17, instructor operating station).
	1) surface wind speed, direction and gusts;				✓	Where required for specific training tasks the following effects should be included: • katabatic winds; and • mountain effects (rotors, demarcation lines, etc.).
	2) intermediate and high altitude wind speed and direction;				✓	Where required for specific training tasks the following effects should be included: • wake vortices and downwash from other aircraft.
	3) thunder storms and microbursts;				✓	
	4) turbulence; and				✓	Where required for specific training tasks the following effects should be included: • rig exhaust turbulence; • wind masking due to buildings, trees, etc.; and
	(ctd on next page)					

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER	G	R1	R	S	COMMENTS
						• turbulence and wind effects caused by topography and structures.
	5) wind shear.				✓	Where required for specific training tasks.
11.4.R	The following features should be simulated, with appropriate instructor controls provided:					A subjective test is required. See Part III, Appendix C, table of functions and subjective tests (test 17, instructor operating station).
	1) surface wind speed, direction and gusts;			✓		
	2) intermediate and high altitude wind speed and direction;			✓		
	3) thunderstorms and microbursts; and			✓		
	4) turbulence.			✓		
11.4.G	The following features should be simulated with appropriate instructor controls provided:					A subjective test is required. See Part III, Appendix C, table of functions and subjective tests (test 17, instructor operating station).
	1) wind speed and direction; and	✓				
	2) turbulence.	✓				

12. REQUIREMENT — ENVIRONMENT — LANDING AREAS AND TERRAIN

12.	**FEATURE GENERAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN**	**G**	**R1**	**R**	**S**	**COMMENTS**
12.S	**Helipad, heliport and/or airport: correct terrain modelling, runway orientation, markings, lighting, dimensions and taxiways.** **Terrain: visual texturing to give sufficient cues to permit pilots to determine speed, altitude and position information to support the training task.** **Terrain and EGPWS databases should be matched.**				✓	**Geospecific scene content** **Daylight scene will include sky and terrain suitably coloured and textured to clearly identify aircraft attitude.** **Night scene will include stars, ground lights, and sufficient texture to clearly identify the aircraft attitude and differentiate between the terrain and sky.** **Colours and textures will represent a particular geographic area environment as appropriate to the training task, i.e. normal vegetation, desert, arctic or jungle. Ground objects will be presented in sufficient quantity to permit orientation and alignment for ground reference manoeuvring (i.e. traffic pattern and or high/low reconnaissance).** **All ground objects must be presented in proper size and perspective, presenting no distraction to the pilot. Day or night horizon representation can be obscured by multiple ragged or solid cloud layers adjustable for bottom and top of layer corresponding to the aircraft altitude.** **The scene must permit adjustable visibility obscuration (haze or fog) and present a representation of precipitation (rain and snow).** **Airborne or ground traffic capability.** (ctd on next page)

12.	FEATURE GENERAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	G	R1	R	S	COMMENTS
						<u>Miscellaneous content</u> **Downwash effects simulated within local environment, 3-D model of sea state as required for training, tree movement in confined areas, highly detailed close-up landing effects, sloping ground.**
12.R	**<u>Helipad, heliport or airport</u>: as for the generic requirement of 12.G plus at least one fully customized 3-D airport/heliport model.** **<u>Terrain</u>: to include topographical information, such as buildings, trees, obstacles (as well as other features, such as unprepared landing sites, confined areas, ships, rigs, if required) that allows VFR navigation training.** **Interactive 3-D sea states should be included if required for training.** **<u>For VFR cross-country training</u>: the capability to replicate ground visual references and topographical features sufficient to support VFR navigation according to appropriate charts (typically 1:500 000, 1:250 000, 1:100 000 scale mapping).**			✓		**It should be representative of a typical airfield or landing site, including terrain surface (grass, tarmac) and characteristics (soft, hard, slippery) but not necessarily geospecific.** **Where the device is required to perform low visibility operations, there should be at least one airport scene with functionality to support the required approval level, e.g. low visibility taxi route with marker boards, stop bars, runway guard lights plus the required approach, runway and taxiway lighting. It should include whiteout/brownout, surface features (downwash, moving grass and sea surface).** **<u>Scene content</u>** **Daylight scene will include sky and terrain suitably coloured and textured to clearly identify aircraft attitude.** **Night scene will include stars, ground lights, and sufficient texture to clearly identify the aircraft attitude and differentiate between the terrain and sky.** **Colours and textures will represent a particular geographic area environment as appropriate to the training task, i.e. normal vegetation, desert, arctic, or jungle.** (ctd on next page)

12.	FEATURE GENERAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	G	R1	R	S	COMMENTS
						Ground objects will be presented in sufficient quantity to permit orientation and alignment for ground reference manoeuvring (i.e. traffic pattern and/or high/low reconnaissance), hovering and taxiing. All ground objects must be presented in proper size and perspective, presenting no distraction to the pilot. **Day or night horizon representation can be obscured by multiple ragged or solid cloud layers adjustable for bottom and top of layer corresponding to the aircraft altitude.** **The scene must permit adjustable visibility obscuration and present a representation of precipitation (rain and snow).** **Airborne or ground traffic capability.**
12.G	**Generic airport/heliport model(s) with terrain topographical features to support the intended use. It should have a visible horizon.** **Daylight, dusk and night visual scenes with the capability to display sufficient scene content to recognize generic aerodromes, heliports, terrain and landmarks around the Final Approach and Take-off (FATO) area and to accomplish low airspeed/low altitude manoeuvres to include lift-off, hover, translation to and from the hover into forward flight, landing and touchdown adequate for instrument training.**	✓				**It should include runway and taxiway markings and lighting.** **A limited area flat world is acceptable.** **The rotor blade tip path plane should be visible.** **The daylight scene should include sky and terrain suitably coloured to clearly identify the aircraft attitude.** **The night scene should include stars, ground lights, and sufficient texture to clearly identify the aircraft attitude and differentiate between the terrain and sky.** **Day or night horizon representation can be obscured by a solid cloud layer adjustable for bottom and top of layer corresponding to the aircraft altitude.** (ctd on next page)

12.	FEATURE GENERAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	G	R1	R	S	COMMENTS
						The scene should permit adjustable obscuration (haze or fog). Terrain does not need to represent any geospecific location.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	G	R1	R	S	COMMENTS
12.1	AIRPORT/LANDING AREA SCENES					
12.1.S	The following is the minimum airport/landing area model content requirement to satisfy visual capability tests, and provide suitable visual cues to allow completion of all functions and subjective tests described in Appendix C to this Part. There must be at least the following airport/helicopter landing areas: • at least one (1) specific real world airport or heliport; and • at least three non-airport landing areas, as follows: – at least one (1) helicopter landing area situated on a substantially elevated surface with respect to the surrounding structures or terrain (e.g. building top, offshore oil rig); – at least one (1) helicopter landing area that meets the definition of a "confined landing area"; and – at least one (1) helicopter landing area on a sloped surface where the slope is at least 2.5°.				✓	The designated real-world airport or heliport should be part of the approved training programme. *Note.— The requirements should be read in conjunction with Part III, Appendix C, table of functions and subjective tests (test 12, visual system) to fully understand the details to be provided.*
12.1.R	A minimum of one (1) airport or heliport and one (1) helicopter landing area model. The airport or heliport and the helicopter landing area may be contained within the same model. If this option is selected, the approach path to the airport runway(s) and the approach path to the helicopter landing area must be different.			✓		The fidelity of the visual scene must be sufficient for the aircrew to visually identify the airport and/or helicopter landing area; determine the position of the simulated helicopter within the visual scene; successfully accomplish take-offs, approaches, and landings; and manoeuvre around the airport on the ground, or in hover taxi, as necessary. (ctd on next page)

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	G	R1	R	S	COMMENTS
						The airport, heliport or helicopter landing area may be either fictional or real-world. *Note.— The requirements should be read in conjunction with Part III, Appendix C, table of functions and subjective tests (test 12, visual system) to fully understand the details to be provided.*
12.1.G	The system should include a generic airport with a helicopter landing area available.	✓				*Note.— The requirements should be read in conjunction with Part III, Appendix C, table of functions and subjective tests (test 12, visual system) to fully understand the details to be provided.*
12.2	AIRPORT OR HELIPORT CURRENCY					
12.2.S	The specific airport or heliport modelled in the system should be maintained current with the state of the corresponding real-world airport or heliport as identified in the airport or heliport charts.				✓	The selection of the airport or heliport scenes to be agreed with the NAA. Changes should be incorporated in the simulator database within six months of being implemented in the corresponding real-world airport or heliport. An update is required when, for example, additional runways or taxiways are added; when existing runway(s) are lengthened or permanently closed; when magnetic bearings to or from a runway are changed; when significant and recognizable changes are made to the terminal, other buildings, or surrounding terrain, etc., but does not need to include changes to minor buildings or other less important features not represented on the airport or heliport charts.
12.2.R	N/A.					
12.2.G	N/A.					

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	G	R1	R	S	COMMENTS
12.3	VISUAL ENVIRONMENT DETAIL					
12.3.S	Visual cues to assess sink rate and enable depth perception during take-off and landing should be provided. Highly detailed and accurate surface depiction of the terrain surface within an area sufficient to achieve cross-country flying under VFR conditions.				✓	Terrain surface references and topographical features should be adequate to navigate using appropriate charts (typically 1:500 000, 1:250 000, 1:100 000 scale mapping).
12.3.R	Visual cues to assess sink rate and enable depth perception during take-off and landing should be provided. Highly detailed and accurate surface depiction of the terrain surface within an approximate area from 400 m (1/4 sm) before to 400 m (1/4 sm) beyond the runway approach end with a total width of approximately 400 m (1/4 sm) including the width of the runway.			✓		
12.3.G	Textured surfaces to assess sink rate and enable depth perception during take-off and landing should be provided.	✓				
12.4	SCENE CONTENT					
12.4.S	The visual system should be capable of producing, as a minimum, scene content comparable in detail to that produced by 10 000 polygons and 5 000 visible light-points for night, dusk and day scenes for the entire visual system.				✓	
12.4.R	The visual system should be capable of producing, as a minimum, scene content comparable in detail to that produced by 6 000 polygons and 5 000 visible light-points for night, dusk and day scenes for the entire visual system.			✓		

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — LANDING AREAS AND TERRAIN	G	R1	R	S	COMMENTS
12.4.G	The visual system should be capable of producing, as a minimum, scene content comparable in detail to that produced by 6 000 polygons and 1 000 visible light-points for night, dusk and day scenes for the entire visual system.	✓				
12.5	SPECIAL EFFECTS					
12.5.S	The following effects should be capable of being displayed: 1) downwash effects including brownout and whiteout; 2) sea states including the resulting movement of ships used for deck landings; 3) effects of wind lanes on water surface; 4) movement of trees and grass in confined area landing sites; and 5) ground static and moving traffic and airborne traffic capable of conflicting with own aircraft.				✓	Ship movement should at least conform to the sea state in pitch, roll and heave.
12.5.R	The following effects should be capable of being displayed: 1) downwash effects including brownout and whiteout; 2) sea states including the resulting movement of ships used for deck landings; 3) effects of wind lanes on water surface; and 4) ground static and moving traffic and airborne traffic capable of conflicting with own aircraft.			✓		
12.5.G	N/A.					

13. REQUIREMENT — ENVIRONMENT — ATC

13.	FEATURE GENERAL REQUIREMENT ENVIRONMENT – ATC	G	R1	R	S	COMMENTS
13.S	**Automated dynamic environment in the terminal area, including ATC responses to ownship voice transmissions and appropriate ATC initiated transmissions to support the intended use.** **Content and intensity of ownship and othership messages specific to airport or heliport context and frequency, in English (as per Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*). Randomized messages to ownship and othership messages specific to airport or heliport. Correlation with visual ground, landing and departing traffic, including terminal area simulation of airports or heliports appropriate to the training programme.**				✓	**Recognizing that the implementation of a dynamic ATC environment has not yet been evaluated and verified through training, the progress towards this level is expected to take place over a period of time.** **Therefore the requirements listed for ATC environment in this section are intended as goals that should be achievable in the next few years but are recognized as not being required at this time.**
13.R	**Flight phase and content-specific ATC messages in the terminal area, including appropriate responses to ownship voice transmissions to support the intended use.** **Context and intensity of ownship and othership messages in English (as per Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management).* Randomized messages to ownship and background messages representative of ATC control.**			✓		
13.G	**Flight phase and content-specific ATC messages, including responses to ownship voice transmissions in appropriate flight phases, to support the intended use.** (ctd on next page)	✓				

13.	FEATURE GENERAL REQUIREMENT ENVIRONMENT – ATC	G	R1	R	S	COMMENTS
	Content of ownship messages in English (as per Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*). **Messages to ownship typical of ATC control.** **Can be achieved by the instructor providing the ATC simulation.**					

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	G	R1	R	S	COMMENTS
13.1	AUTOMATED WEATHER REPORTING					Automated weather reporting provides pilots with essential information about weather conditions and air traffic control operational information. ATIS and other automated weather information may also be provided by datalink to the cockpit. While ATIS is the most common of these automated systems, other automated weather broadcasts, such as ASOS or AWOS, in use at airports or heliports with part-time or no towers should be considered where relevant to the operation.
13.1 S	Multiple station automated weather reporting.				✓	The system should have the capability of generating different automated weather reporting messages providing weather conditions and different other predefined conditions at all airports or heliports in range allowing flight crews to simultaneously listen in to concurrent automated weather reporting messages from different airports or heliports. The instructor should have the ability to override each single value and each predefined message from the instructor station.
13.1 R	Single station automated weather reporting.			✓		At least one automated weather reporting message is required for all airports or heliports in range. The message(s) should consist of the actual weather conditions set in the FSTD including reference airport/heliport, reference runway, temperature, wind, QNH, clouds, visibility, runway conditions as well as predefined other conditions (transition level, etc.), which cannot be read out from the simulation. The instructor should have the ability to change the weather conditions and other predefined conditions for the automated weather reporting message from the instructor station. These instructor inputs need not influence the actual weather conditions of the simulation.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	G	R1	R	S	COMMENTS
13.1 G	Single station automated weather reporting.	✓				At least one automated weather reporting message is required for all airports or heliports in range. The message(s) should consist of the actual weather conditions set in the FSTD including reference airport/heliport, reference runway, temperature, wind, QNH, clouds, visibility, runway conditions as well as predefined other conditions (transition level, etc.), which cannot be read out from the simulation.
13.2	BACKGROUND CHATTER					
13.2.1 S, R, G	Background chatter (party line). In general all background chatter should meet the following criteria: 1) communications should make sense within the context of the simulation environment and should not contain obviously erroneous information; 2) only messages relevant to the purpose of a given frequency should be heard on said frequency; 3) simulated communications on a given frequency should not step over one another or over communications from the simulator crew; and 4) reasonable pauses should be provided between communication exchanges to allow the simulator crew access to the frequency when required.	✓		✓	✓	Party line communications simulate background chatter heard in the cockpit, e.g. aircraft-to-aircraft, aircraft-to-ground, or ground-to-ground communications other than ownship.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	G	R1	R	S	COMMENTS
13.2.2 S	Content-defined — Location-specific and content-specific messages fully correlated to the visually simulated traffic.				✓	Content-defined background chatter. Background chatter communications simulation should provide party line communications that are tailored to the simulation context, both in form and content. Location-specific procedures and nomenclature should be accurately reflected, and all communications should be fully correlated to the visual representation of the traffic activities. The number of voices should be sufficient to allow differentiation of the various ATC services and pilots. The system should include a minimum of three specific terminal areas. The three specific terminal areas should be part of the approved training programme.
13.2.2 R	Context-defined — Generic messages common to all airports/ heliports correlated to visually simulated traffic.			✓		Context-defined background chatter. Background chatter communications simulation should generate messages with context-specific content based on a generic typical format that would be common to all locations. The background chatter should correlate with the traffic scenario and should not conflict with the ownship position and movements. The communications should also be correlated to the visual representation of the traffic activities. The number of voices should be sufficient to allow differentiation of the various ATC services and pilots. The system should include a minimum of three specific terminal areas. The three specific terminal areas should be part of the approved training programme.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	G	R1	R	S	COMMENTS
13.2.2 G	Context-generic — Generic messages with no correlation.	✓				Background chatter communications simulation can be based on generic messages only. Such messages should be defined in such a way that they require no or very little information to be adapted to the simulation context. The voices used need only be diverse enough to avoid confusion between pilots and ATC services.
13.3	ATC SIMULATION — INTERACTION WITH SIMULATOR					Messages received related to ownship position, operational situation and environmental conditions reflecting visual settings and TCAS scenario, if applicable.
13.3 S, R	Simulation Parameters The ATC communication simulation system together with helicopter systems and applicable environment simulation shall provide the following parameters: 1) wind direction/speed/gust; 2) QNH/QFE (altimeter setting); 3) temperature: OAT; 4) dew point; 5) cloud conditions: height and type; 6) visibility; 7) RVR (fog/ground fog/patchy fog); 8) special weather condition set: rain, snow (with wind effects), turbulence, icing, expected wind shear, microburst, and storm clouds/cells with approximate position; (ctd on next page)			✓	✓	The system should include a minimum of three specific terminal areas. The three specific terminal areas should be part of the approved training programme. Including visual, when applicable.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	G	R1	R	S	COMMENTS
	9) active runways; 10) runway condition: contamination and depth of contamination; 11) braking action; 12) UTC; 13) position, track, heading and height of own helicopter; and 14) subject helicopter call sign.					
13.4	ATC SIMULATION – INTERACTION WITH INSTRUCTOR					
13.4 S, R	The instructor should be able to interact with the scenario by injecting messages to the ownship helicopter. When applicable, these messages should be grouped by phase of flight or category as follows: 1) gate: a) dispatch; b) maintenance; c) departure ATIS; d) route clearance; e) pushback; and f) other routine ATC/company communication; (ctd on next page)			✓	✓	Regardless of how the ATC simulation is provided, consideration must be given to the workload placed upon the instructor as part of the ATC simulation to ensure it does not significantly distract from the observation of the crew members under training, testing or checking.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	G	R1	R	S	COMMENTS
	2) de-icing; 3) taxi; 4) holding position; 5) take-off; 6) after take-off; 7) climb; 8) en-route; 9) descent; 10) arrival ATIS; 11) hold; 12) approach; 13) landing; 14) emergency; 15) other communication; and 16) cabin crew.					

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	G	R1	R	S	COMMENTS
13.5	ATC MESSAGE TRIGGERING					The instructor should be able to trigger messages manually or automatically.
13.5.1 S, R	Manual (basic).			✓	✓	The message is triggered at the instructor's request by an instructor's action from the IOS.
13.5.2 S, R	Automatic (enhanced).			✓	✓	The message is triggered automatically when all the criteria that are relative to the message content (ground or air traffic, phase of flight, weather conditions, etc.) are satisfied. In the event of the ownship not following the ATC instructions, or not following correct readback protocols, the system should provide corrective messages (e.g. ownship not respecting assigned speed, heading or altitude when airborne, or crossing or holding short of assigned runways and taxiways when on the ground).
13.5.3 S, R	The ATC communication simulation system should give to the instructor the ability to pause and/or disable it and return to the classic no-ATC simulation.			✓	✓	
13.6	PHRASEOLOGY					
13.6.1 S, R, G	Phraseology and voice characteristics	✓		✓	✓	To increase training effectiveness it is of utmost importance that the ATC radio communication simulation should reinforce correct phraseology. The focus should be on achieving 100 per cent realism, to achieve proper situational awareness among the students, during training sessions.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	G	R1	R	S	COMMENTS
13.7	FLIGHT PHASE SPECIFIC ATC FREQUENCY RECOGNITION					
13.7.1 S, R, G	Communications should be appropriate to the radio frequencies set in the cockpit: 1) single-frequency communications;	✓		✓	✓	Flight phase specific ATC frequency recognition, a requirement for all levels of ATC simulation, means that all communications received by the pilot should be appropriate to the radio frequencies set in the cockpit.
	2) multiple-frequency communications.	✓		✓	✓	Example: the pilot listening to ATIS on VHF 1 while the co-pilot waits for clearance delivery on VHF 2.
13.7.2 S, R, G	The simulated environment should be kept updated in conjunction with other system updates with regard to company or ATC radio frequency changes.	✓		✓	✓	The facility to use company radio frequencies should be available, but these should not necessarily be linked to "real world" company radio frequencies, providing this does not cause a conflict with existing ATC frequencies.
13.8	INSTRUCTOR CONTROL OVER OTHER TRAFFIC					
13.8.1 S, R, G	Instructor control over other traffic. Instructor should have the ability to control other traffic.	✓		✓	✓	Examples of instructor control of other traffic: 1) priority for ownship for take-off, landing and ground, hover and air manoeuvres with respect to other traffic; 2) another aircraft in the scenario to have an emergency or to obstruct ownship helicopter; 3) levels of traffic activity in the scenario; and 4) restrictions on speed for an approaching aircraft.
13.8.2 S, R	Correlation. Communications should be consistent with other ground and air traffic representations in the simulation and helicopter systems (TCAS).			✓	✓	Air traffic control communications should be consistent with other dynamic ground and air traffic movements, including those influenced by traffic conflicts and subject aircraft priority issues. Traffic information displayed by both visual and onboard systems should be consistent with TCAS.

	FEATURE TECHNICAL REQUIREMENT ENVIRONMENT — ATC	G	R1	R	S	COMMENTS
13.8.3 S, R	Traffic flow. Unless otherwise selected by the instructor, airport/heliport traffic flow should be representative of flow density for the time of day at the modelled airport/heliport. Representative traffic separation times should be respected.			✓	✓	Examples of appropriate traffic flows for a major airport/heliport: <u>Light</u>: 1 to 15 take-offs and/or landings per hour or less than 20 total movements per hour. <u>Medium</u>: 16 to 50 take-offs and/or landings per hour or 70 total movements per hour. <u>Heavy</u>: 51 or more take-offs and/or landings per hour or greater than 100 total movements per hour.
13.9	DATALINK COMMUNICATIONS					
13.9.1 S	ACARS/ATN.				✓	If installed.
13.9.2 S	FANS.				✓	If installed.
13.9.3 S	OTHER.				✓	If installed.

14. REQUIREMENT — MISCELLANEOUS

14.	FEATURE GENERAL REQUIREMENT Miscellaneous	G	R1	R	S	COMMENTS
14.S	N/A.					This "miscellaneous" feature is defined in Part I, 6.1.14, is not directly related to the training perspective and is thus not included in the FSTD Summary Matrix of Part II, Chapter 2. Therefore, "N/A" is shown for the three listed fidelity levels. However, the relevant items of this feature have tests described in the rest of this paragraph.
14.R	N/A.					
14.G	N/A.					

14	FEATURE TECHNICAL REQUIREMENT Miscellaneous	G	R1	R	S	COMMENTS
14.1	INSTRUCTOR OPERATING STATION					
14.1 S	The instructor operating station should provide an adequate view of the pilots' panels and forward windows.				✓	For an FSTD with a motion cueing system, any on board instructor seat should be adequately secured and fitted with positive restraint devices of sufficient integrity to safely restrain the occupant during any known or predicted motion system excursion. If an EFVS is installed, the instructor operating station should include an EFVS display repeater of the EFVS being simulated, as seen through the pilot's HUD or the cockpit displays. This includes any displayed data and symbology. The display format (aspect ratio) should be replicated.
14.1 R	The instructor operating station should provide an adequate view of the pilots' panels and forward windows.			✓		
14.1 G	N/A.					
14.2	INSTRUCTOR CONTROLS					
14.2 S, R, G	The instructor operating station should have controls that enable the instructor to control all required system variables and insert all abnormal or emergency conditions into the simulated helicopter systems, as appropriate. The instructor operating station should have controls for all environmental effects expected to be available at the instructor operating station (e.g. clouds, visibility, icing, precipitation, temperature, storm cells, and wind speed and direction). (ctd on next page)	✓		✓	✓	

14	FEATURE TECHNICAL REQUIREMENT Miscellaneous	G	R1	R	S	COMMENTS
	The instructor operating station should provide to the instructor the ability to present ground and air hazards. It should provide to the instructor the ability to present the effect of recirculating dust, water vapour, or snow conditions that develop as a result of rotor downwash.					
14.3	SELF–DIAGNOSTIC TESTING					
14.3 S	Self-diagnostic testing of the FSTD should be available to determine the integrity of hardware and software operation and to provide a means for quickly and effectively conducting daily testing of the FSTD software and hardware.				✓	An SOC is required.
14.3 R, G	N/A.					
14.4	COMPUTER CAPACITY					
14.4 S, R, G	Sufficient FSTD computer capacity, accuracy, resolution and dynamic response should be provided to fully support the overall FSTD fidelity needed to meet the qualification type sought.	✓		✓	✓	An SOC is required.
14.5	AUTOMATIC TESTING FACILITIES					
14.5 S	Automatic QTG/validation testing of FSTD hardware and software to determine compliance with the validation requirements should be available.				✓	Evidence of testing should include test identification, FSTD number, date, time, conditions, tolerances, and the appropriate dependent variables portrayed in comparison with the helicopter standard.
14.5 R, G	Validation testing of FSTD hardware and software to enable recurrent testing should be available.	✓		✓		Evidence of testing should include test identification, FSTD number, date, time, conditions, tolerances, and the appropriate dependent variables portrayed in comparison with the master QTG test standard. Automatic QTG validation/testing is encouraged.

14	FEATURE TECHNICAL REQUIREMENT Miscellaneous	G	R1	R	S	COMMENTS
14.6	UPDATES TO FSTD HARDWARE AND SOFTWARE					
14.6 S, R	Timely permanent update of FSTD hardware and software should be conducted subsequent to helicopter modification where it affects training, sufficient for the qualification type sought.			✓	✓	
14.6 G	Timely permanent update of FSTD hardware and software should be conducted subsequent to FSTD manufacturer recommendation where it affects training and/or safety.	✓				
14.7	DAILY PRE-FLIGHT DOCUMENTATION					
14.7 S, R, G	Daily pre-flight documentation either in the daily log or in a location easily accessible for review is required.	✓		✓	✓	
14.8	SYSTEM INTEGRATION					
14.8	System Integration Relative response of the visual system, cockpit instruments and initial motion system coupled closely to provide integrated sensory cues. Visual scene changes from steady state disturbance (i.e. the start of the scan of the first video field containing different information) should occur within the system dynamic response limit of 85 or 120 milliseconds (ms) depending on the FSTD type. Motion onset should also occur within the system dynamic response limit of 85 or 120 ms depending on the FSTD type. While motion onset should occur before the start of the scan of the first video field containing different information, it needs to occur before the end of the scan of the same video field. (ctd on next page)					A test is required. See Part III, Appendix B (test 6.a,1, transport delay). A latency test may be used as an alternate means of compliance in place of the transport delay test. Part II, Attachment G provides guidance for transport delay and latency test methodologies.

14	FEATURE TECHNICAL REQUIREMENT Miscellaneous	G	R1	R	S	COMMENTS
	The test to determine compliance with these requirements should include simultaneously recording the output from the pilot's pitch, roll and yaw controllers, the output from the accelerometer attached to the motion system platform located at an acceptable location near the pilots' seats, the output signal to the visual system display (including visual system analogue delays) and the output signal to the pilot's attitude indicator or an equivalent test approved by the NAA.					
14.8 S	Transport delay: A transport delay test should be used to demonstrate that the FSTD system response does not exceed 85 ms. Where EFVS systems are installed, they should respond within + or - 30 ms from the visual system, and not before the motion response.				✓	Results required for instruments, motion and visual systems. Additional transport delay test results are required where HUD systems are installed, which are simulated and not actual helicopter systems. Where a visual system's mode of operation (daylight, twilight and night) can affect performance, additional tests are required. An SOC is required where the visual system's mode of operation does not affect performance, precluding the need to submit additional tests.
14.8 R, G	Transport delay: A transport delay test should be used to demonstrate that the FSTD system response does not exceed 120 ms.	✓		✓		Results required for applicable systems only.
14.9	RECORD, FREEZE AND PLAYBACK					
14.9 S, R, G	Record, freeze and playback capability.	✓		✓	✓	

14	FEATURE TECHNICAL REQUIREMENT Miscellaneous	G	R1	R	S	COMMENTS
14.10	BRIEFING AND DEBRIEFING					
14.10 S, R, G	Briefing and debriefing capability.	✓		✓	✓	

Appendix B

FSTD VALIDATION TESTS

1. INTRODUCTION

Refer to Volume II, Part II, Appendix B, Section 1.

2. TEST REQUIREMENTS

Refer to Volume II, Part II, Appendix B, Section 2.

3. INFORMATION FOR VALIDATION TESTS

Refer to Volume II, Part II, Appendix B, Section 3.

4. TABLE OF FSTD VALIDATION TESTS

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.	**PERFORMANCE**							All the one engine inoperative tests in this section are applicable to multi-engine helicopters only.
1.a.	**Engine Assessment**							
1.a.	1) Start operation. i) Engine start and acceleration (transient).	Light off time ± 10% or ± 1 s. Torque ± 5%. Rotor speed ± 3%. Gas generator speed ± 5%. Power turbine speed ± 5%. Turbine gas temperature ± 30°C.	Ground, rotor brake not used and rotor brake used (if applicable).				✓	Time histories of each engine from initiation of start sequence to steady state idle and from steady state idle to operating RPM. For a multi-engine helicopter, the test should be presented as a start of two engines in sequence. Tolerance to be applied only in the validity domain of the engine parameter sensors.
	ii) Steady state idle and operating RPM conditions.	For S fidelity level: Torque ± 3%. Rotor speed ± 1.5%. Gas generator speed ± 2%. Power turbine speed ± 2%. Turbine gas temperature ± 20°C.	Ground.				✓	Data should be presented for both steady state idle and operating RPM conditions. It may be a snapshot test.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
		<u>For G and R fidelity levels</u>: Torque ± 3%. Rotor speed ± 1.5%.		C T & M		✓		
1.a.	2) Power turbine speed trim.	± 10% of total change of power turbine speed or ± 1.5% rotor speed.	Ground.				✓	Time history of engine response to trim system actuation (both directions).
1.a.	3) Engine and rotor speed governing.	Torque ± 5%. Rotor speed ± 1.5%.	Climb and descent.				✓	Collective step inputs. Can be conducted with climb and descent performance tests. Two tests are required: – one test demonstrating collective up input; and – one test demonstrating a collective down input.
1.b.	**Ground operations**							
1.b.	1) Reserved.							
1.b.	2) Rate of turn vs pedal deflection or steering wheel angle.	Turn rate ± 10% or ± 2°/s.	Ground.				✓	Without use of wheel brake. Test to demonstrate the helicopter response to both direction inputs.
1.b.	3) Taxi.	Torque ± 3%. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%.	Ground.				✓	Control position during ground taxi for a specific ground speed and direction, and density altitude.
1.b.	4) Reserved.							

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.c.	**Take-off**							When the speed range for the following tests is less than 40 knots, the applicable airspeed tolerance may be applied to either airspeed or ground speed, as appropriate. If height is not available altitude may be used.
1.c.	1) All engines.	For S fidelity level: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 2°. Heading ± 2°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Hover.				✓	Time history of take-off flight path as appropriate to helicopter model simulated and FSTD type. Take-off from hover IGE. Record data to at least 61 m (200 ft) AGL/V_y whichever comes later.
		For R fidelity level: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 2.5°. Roll angle ± 2°. Heading ± 2°.				✓		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.c.	2) One engine inoperative continued take-off.	<u>For S fidelity level</u>: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 2°. Heading ± 2°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Hover.				✓	Time history of take-off flight path as appropriate to helicopter model simulated. Record data to at least 61 m (200 ft) AGL/V_y whichever comes later. This test corresponds to an open field CAT A take-off with an engine failure after TDP. *Note.— See paragraph 1.7 in Attachment J to Part II, about the possibility of deriving reference data in OEI condition for a helicopter equipped with an OEI training mode.*
		<u>For R fidelity level</u>: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 2.5°. Roll angle ± 2°. Heading ± 2°.				✓		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.c.	3) One engine inoperative rejected take-off	<u>For S fidelity level</u>: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3% Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 1.5°. Heading ± 2°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%. Distance: ± 7.5% or ± 30 m (100 ft).	Hover.				✓	Time history from the take-off point until touchdown. Test conditions near limiting performance. This test corresponds to an open field CAT A take-off with an engine failure before TDP. *Note.— See paragraph 1.7 in Attachment J to Part II, about the possibility of deriving reference data in OEI condition for a helicopter equipped with an OEI training mode.*
		<u>For R fidelity level</u>: Airspeed ± 3 kts Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 2.5°. Roll angle ± 1.5°. Heading ± 2°. Distance: ± 7.5% or ± 30 m (100 ft).				✓		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.c.	4) Lift-off to hover	Torque ± 5%. Pitch angle ± 2°. Roll angle ± 2°. Heading ± 3°. Longitudinal control position ± 10%. Lateral control position ± 10% Directional control position ± 10%. Collective control position ± 10%.	Ground. Augmentation ON or OFF.				✓	Record a manoeuvre starting on ground with collective full down till stabilized in hover IGE.
1.d.	**Hover performance**	<u>For S and R fidelity levels</u>: Torque ± 3%. Pitch angle ± 1.5°. Roll angle ± 1.5°. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%.	In ground effect (IGE). Out of ground effect (OGE). Stability augmentation ON and OFF.			✓	✓	Light and heavy gross masses. Four test conditions are required: • 10%, 30% and 70% of rotor diameter height for IGE; and • more than 150% of rotor diameter height for OGE. These may be snapshot tests.
		<u>For G level devices</u>: Torque ± 3%. Collective control position ± 5%.		CT&M				Two test conditions required : • IGE; and • OGE. These may be snapshot tests.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.e.	**Vertical climb performance**	Vertical velocity ± 0.50 m/s (100 ft/min) or ± 10%. Directional control position ± 5%. Collective control position ± 5%.	OGE. Stability augmentation ON and OFF.			✓	✓	Light and heavy gross masses. These may be snapshot tests.
1.f.	**Level flight performance and trimmed flight control position**	Torque ± 3%. Pitch angle ± 1.5°. Sideslip angle ± 2°. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%.	Cruise. Stability augmentation ON or OFF.					These may be snapshot tests. Test results presented as a cross-plot against speed are encouraged.
		For S fidelity level: Tolerances as above.					✓	Two combinations of gross mass/CG and for each combination several speeds from V_y up to V_H within the flight envelope.
		For R fidelity level: Tolerances as above.				✓		Two combinations of gross mass/CG and for each combination several speeds from V_y up to V_H within the flight envelope. Sideslip angle is matched only for repeatability and only on continuing recurrent evaluations.
		For G fidelity level: Tolerances as above.		C T & M				Two combinations of gross mass/CG and for each combination two speed values. Sideslip angle is matched only for repeatability and only on continuing recurrent evaluations.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.g.	**Climb performance and trimmed flight control position**	Vertical velocity ± 0.50 m/s (100 ft/min) or ± 10%. Pitch angle ± 1.5°. Sideslip angle ± 2°. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%. Airspeed ± 3 kts.	All engines operating. One engine inoperative. Stability augmentation ON or OFF.	C T & M		✓	✓	Two gross mass/CG combinations. Data presented at relevant climb power conditions. These may be snapshot tests. Tolerance on speed is only applicable to time history tests. For R and S fidelity levels: The achieved measured vertical velocity of the FSTD cannot be less than the appropriate approved RFM values. For R fidelity level: Sideslip angle is matched for repeatability only and on continuing recurrent evaluations only.
1.h.	**Descent**							
1.h.	1) Descent performance and trimmed flight control position.	Torque ± 3%. Pitch angle ± 1.5°. Sideslip angle ± 2°. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%. Airspeed ± 3 kts.	Powered descent. Stability augmentation ON or OFF.	C T & M		✓	✓	Two gross mass/CG combinations. These may be snapshot tests. Test to demonstrate a significant rate of descent using a normal approach speed. Tolerance on speed is only applicable to time history tests. For R fidelity level: Sideslip angle is matched for repeatability only and on continuing recurrent evaluations only.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.h.	2) Autorotation performance and trimmed flight control position	Vertical velocity ± 0.50 m/s (100 ft/min) or ± 10%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Sideslip angle ± 2°. Longitudinal control position ± 5%. Lateral control position ± 5%. Directional control position ± 5%. Collective control position ± 5%.	Steady descents. Stability augmentation ON or OFF.	C T & M		✓	✓	Two gross mass/CG combinations. Rotor speed tolerance only applies if collective control position is fully down. Speed sweep from approximately the minimum rate of descent airspeed to at least either maximum glide distance airspeed or maximum allowable power-off airspeed, whichever is slower. This may be a series of snapshot tests. For R fidelity level: Sideslip angle is matched for repeatability only and on continuing recurrent evaluations only.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.i.	**Autorotational entry**	For S fidelity level: Torque ± 3%. Rotor speed ± 3%. Pitch angle ± 2°. Roll attitude ± 3°. Heading ± 5°. Airspeed ± 5 kts. Altitude ± 6.1 m (20 ft). Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Cruise and climb.				✓	Time history of helicopter response following a rapid power reduction to idle up to a stabilized autorotation rate of descent and N_R. For cruise, data should be presented for a high speed condition. For climb, data should be presented for the maximum rate of climb airspeed at or near maximum continuous power.
		For R fidelity level: Torque ± 3%. Rotor speed ± 3%. Pitch angle ± 2°. Roll attitude ± 3°. Heading ± 5°. Airspeed ± 5 kts. Altitude ± 6.1 m (20 ft).	Cruise and climb.			✓		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.j.	**Landing**							When the speed range for the following tests is less than 40 knots, the applicable airspeed tolerance may be applied to either airspeed or ground speed, as appropriate. If height is not available altitude may be used.
1.j.	1) All engines.	For S fidelity level: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 2°. Heading ± 2°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Approach to hover.				✓	Time history of approach and landing profile down to IGE hover as appropriate to the helicopter model being simulated.
		For R fidelity level: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 2.5°. Roll angle ± 2°. Heading ± 2°.				✓		Time history of approach and landing profile down to IGE hover as appropriate to the group of helicopters being simulated.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.j.	2) One engine inoperative.	For S fidelity level: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 2°. Heading ± 2°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Approach and landing.				✓	Include data for both CAT A and CAT B approaches and landings as appropriate to the helicopter model being simulated. Test ends when all the elements of the undercarriage are on the ground. *Note.— See paragraph 1.7 of Attachment J about the possibility of deriving reference data in OEI condition for a helicopter equipped with an OEI training mode.*
		For R fidelity level: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 2.5°. Roll angle ± 2°. Heading ± 2°.				✓		Include data for both CAT A and CAT B approaches and landings as appropriate to the group of helicopters being simulated. Test ends when the first element of the undercarriage touches the ground.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.j.	(3) Balked landing/missed approach.	For S fidelity level: Airspeed ± 3 kts. Height ± 6.1 m (20 ft). Torque ± 3%. Rotor speed ± 1.5%. Pitch angle ± 1.5°. Roll angle ± 2°. Heading ± 2°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Approach, one engine inoperative.				✓	Test to demonstrate a missed approach manoeuvre that is performed from an OEI stabilized approach or includes a dynamic engine failure during the approach. *Note.— See paragraph 1.7 of Attachment J about the possibility of deriving reference data in OEI condition for a helicopter equipped with an OEI training mode.*
		For R fidelity level: Airspeed ± 3 kts Height ± 6.1 m (20 ft) Torque ± 3% Rotor speed ± 1.5% Pitch angle ± 2.5° Roll angle ± 2° Heading ± 2°				✓		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.j.	4) Autorotational landing.	Airspeed ± 3 kts. Torque ± 3%. Rotor speed ± 3%. Height ± 6.1 m (20 ft). Pitch angle ± 2°. Roll angle ± 2°. Heading ± 5°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	Approach and touchdown.				✓	Time history of autorotational deceleration and touchdown from a stabilized autorotational descent. If flight test data containing all required parameters for a complete power-off landing are not available from the aircraft manufacturer for this test and other qualified flight test personnel are not available to acquire this data, the operator may coordinate with the NAA to determine if it is appropriate to accept alternative testing means. Alternative approaches for acquiring these data may be acceptable, depending on the aircraft as well as the personnel and the data recording, reduction, and interpretation facilities to be used. These alternative approaches are: 1) a simulated autorotational flare and reduction of rate of descent (R/D) at altitude; or 2) a power-on termination following an autorotational approach and flare.
1.j.	(5) Hover to touchdown.	Torque ± 5%. Pitch angle ± 2°. Roll angle ± 2°. Heading ± 3°. Longitudinal control position ± 10%. Lateral control position ± 10%. Directional control position ± 10%. Collective control position ± 10%.	IGE hover. Stability augmentation ON or OFF.				✓	Record a manoeuvre starting from IGE hover till touchdown ending with collective control full down.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
1.k.	**Level flight acceleration**	For S fidelity level: Airspeed ± 3 kts. Longitudinal, lateral, directional and collective control positions ± 10%. Torque ± 3%. Pitch angle ± 2°. Roll angle ± 2°. Heading ± 2°.	Cruise. Stability augmentation ON or OFF.				✓	Record a coordinated level flight acceleration with a minimum approximate speed range increase from V_y to maximum range airspeed, initiated with a single power increase at the beginning of the manoeuvre (not a continuous increase).
		For R fidelity level: Airspeed ± 3 kts. Torque ± 3%. Pitch angle ± 2°. Roll angle ± 2°. Heading ± 2°.				✓		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.	**Handling Qualities**							
2.a.	**Control System Mechanical Characteristics**							
	Note 1.— Pitch, roll, yaw and collective controller position versus force or time should be measured at the control. An alternative method in lieu of external test fixtures at the flight controls would be to have recording and measuring instrumentation built into the FSTD. The force and position data from this instrumentation could be directly recorded and matched to the helicopter data. Provided the instrumentation was verified by using external measuring equipment while conducting the static control checks, or equivalent means, and that evidence of the satisfactory comparison is included in the MQTG, the instrumentation could be used for both initial and recurrent evaluations for the measurement of all required control checks. Such a permanent installation could be used without any time being lost for the installation of external devices. *Verification of the instrumentation by using external measuring equipment should be repeated if major modifications and/or repairs are made to the control loading system.* *Note 2.— FSTD static control testing (tests 2.a.1 and 2.a.2) from the second set of pilot controls is required only if both sets of controls are not mechanically interconnected on the FSTD. A rationale is required from the data provider if a single set of data is applicable to both sides. If controls are mechanically interconnected in the FSTD, a single set of tests is sufficient. Dynamics testing is not required at both pilot positions.* *Note 3.— For the control sweep tests (tests 2.a.1, 2.a.2 and 2.a.3), in order to enable validation of steep force gradients near control stops, an additional tolerance of ± 1.5% of total travel on the position axis should be applied.* Contact your NAA for clarification of any issue regarding helicopters with reversible controls or where the required validation data are not attainable.							
2.a.	1) Cyclic.	Breakout ± 0.111 daN (0.25 lbf) or ± 25%. Force ± 0.222 daN (0.5 lbf) or ± 10%.	Ground. Static conditions with the hydraulic system (if applicable) pressurized. Supplemental hydraulic pressurization system may be used. Trim ON and OFF. Friction OFF. Stability augmentation (if applicable) ON and OFF.	C T & M		✓	✓	Record results for an uninterrupted control sweep to the stops (this test does not apply if aircraft hardware modular controllers are used). Flight test data for this test do not require the rotor to be engaged/ turning. The words "if applicable" regarding stability augmentation systems mean: if an augmentation system is available and if this system may be operational on the ground under static conditions as described here. <u>For the G fidelity level</u>: Control forces and travel should broadly correspond to those of the group of helicopters being simulated.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.a.	2) Collective/Pedals.	Breakout ± 0.222 daN (0.5 lbf) or ± 25%. Force ± 0.445 daN (1.0 lbf) or ± 10%.	Ground. Static conditions with the hydraulic system (if applicable) pressurized. Supplemental hydraulic pressurization system may be used. Trim ON and OFF. Friction OFF. Stability augmentation (if applicable) ON and OFF.	C T & M		✓	✓	Record results for an uninterrupted control sweep to the stops. Flight test data for this test do not require the rotor to be engaged/turning. The words "if applicable" regarding stability augmentation systems mean: if an augmentation system is available and if this system may be operational on the ground under static conditions as described here. <u>For the G fidelity level</u>: Control forces and travel should broadly correspond to those of the group of helicopters being simulated.
	3) Brake pedal force vs position.	Force ± 2.224 daN (5 lbf) or ± 10%.	Ground. Static conditions.			✓	✓	FSTD computer output results may be used to show compliance. When the aircraft braking system is an independent system, the tolerances should be applied only on the breakout and maximum deflection.
	4) Trim system rate (all applicable systems).	Rate ± 10%.	Ground. Static conditions. Trim ON. Friction OFF.			✓	✓	The tolerance applies to the recorded value of the trim rate.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.a.	5) Control Dynamics (all axes).	**For underdamped systems** (as per Figure B-1 of Appendix B to Part II): $T(P_0)$ ± 10% of P_0 or ± 0.05 s. $T(P_1)$ ± 20% of P_1 or ± 0.05 s. $T(P_2)$ ± 30% of P_2 or ± 0.05 s. $T(P_n)$ ± 10*(n+1)% of Pn or ± 0.05 s. $T(A_n)$ ± 10% of A_{max}, where A_{max} is the largest amplitude of the first overshoot or ± 0.5% of the total control travel (stop to stop). $T(A_d)$ ± 5% of A_d = residual band or ± 0.5% of the total control travel = residual band. Oscillations within the residual band are not considered significant and are not subject to tolerances. (ctd on nex page)	Ground. Static for irreversible flight control systems. Trim ON. Friction OFF.				✓	Results must be recorded for a normal control displacement in both directions in each axis. Typically, control displacement of 10% to 20% of total control travel is necessary for proper excitation. Control dynamics for reversible control systems should be evaluated in flight considering safety issues or using an alternate method to be proposed to and agreed with the NAA on a case-by-case basis. Additional information on control dynamics is found in paragraphs 3.2.2 to 3.2.5 of Appendix B to Part II. “n” is the sequential period of a full cycle of oscillation. For any control (typically pedals and collective) that does not exhibit any spring characteristics, an alternate method to demonstrate compliance should be run such as running control sweep at high speed. Refer to paragraph 3.2.3 of Part II, Appendix B.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.a.	5) ctd.	± 1 significant overshoots (minimum of 1 significant overshoot). Steady state position should be within residual band. **For overdamped and critically damped systems only**, the following tolerance applies: $T(P_0)$ ± 10% of P_0 or ± 0.05 s.						
2.b.	**Low airspeed handling qualities**							
2.b.	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, and forward flight. Stability augmentation ON or OFF.			✓	✓	Record results for several speed increments to the translational airspeed limits and up to 45 kts forward airspeed (at least four values for the forward flight). This may be a series of snapshot tests. Presenting test results as a cross-plot against speed is encouraged.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.b.	2) Critical azimuth (or azimuth of minimum control margin)	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 or OFF.				✓	Record results for three relative wind directions (including the most critical case) in the critical quadrant. An SOC is required to define from the helicopter design and RFM or flight test data how to present the results showing the area where the minimum control margin applies. This may be a series of snapshot tests. Precise wind measurement is very difficult and simulated wind obtained by translational flight in calm weather condition (no wind) is preferred in order to control precisely flight conditions by using groundspeed measurement (usually GPS). In this condition, it would be more practical to collect validation data for this test with tests 2.b (1) in order to ensure consistency between critical azimuth and other directions (forward, sideward and rearward).
2.b.	3) Control response.							Record results for a step control input on the test axis. The off-axes response must show correct trend. This is a short time test that may be conducted in ground effect to provide better visual reference. The control response tests consist of the four tests (3a) to (3d) below.
2.b.	3a) Longitudinal.	Pitch rate ± 10% or ± 2°/s. Pitch attitude change ± 10% or ± 1.5°.	Hover. Stability augmentation ON and OFF.				✓	Attitude change is defined as the attitude change from the value just before the step input. The tolerance is applied continuously from the step input time.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.b.	3b) Lateral.	Roll rate ± 10% or ± 3°/s. Roll attitude change ± 10% or ± 3°.	Hover. Stability augmentation ON and OFF.				✓	Attitude change is defined as the attitude change from the value just before the step input. The tolerance is applied continuously from the step input time.
2.b.	3c) Directional.	Yaw rate ± 10% or ± 2°/s. Heading change ± 10% or ± 2°.	Hover. Stability augmentation ON and OFF. Both directions.				✓	Attitude change is defined as the attitude change from the value just before the step input. The tolerance is applied continuously from the step input time.
2.b.	3d) Vertical.	Normal acceleration ± 0.1 g. Vertical velocity ± 10% or ± 0.50 m/s (100 ft/min).	Hover Stability augmentation ON and OFF.				✓	

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.c.	**Longitudinal handling qualities**							
2.c.	1) Control response.	Pitch rate ± 10% or ± 2°/s. Pitch attitude change ± 10% or ± 1.5°.	Cruise. Stability augmentation ON and OFF.			✓	✓	Results should be recorded for two cruise airspeeds to include minimum power required speed. Record results for a step control input on the test axis. The off-axes response should show correct trend. Attitude change is defined as the attitude change from the value just before the step input. The tolerance is applied continuously from the step input time.
2.c.	2) Static stability.	Longitudinal control position change from trim: ± 10% or ± 6.3 mm (0.25 in.); or Longitudinal control force change from trim: ± 0.222 daN (0.5 lbf) or ± 10%.	Cruise or climb. Autorotation. Stability augmentation ON or OFF. Stability augmentation ON and OFF conditions are required if the augmentation system includes airspeed regulation.			✓	✓	Record results for a minimum of two speeds on each side of the trim speed taken as reference. This may be a series of snapshot tests.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.c.	3) Dynamic stability.							The dynamic stability tests consist of the two tests (3a) and (3b) below.
2.c.	3a) Long-term response.	± 10% of calculated period. ± 10% of time to 1⁄2 or double amplitude or ± 0.02 of damping ratio. For non-periodic responses, the time history must be matched over a 20 s period following release of the controls within ± 20% or ± 3° of pitch attitude change; and ± 5 kts of airspeed.	Cruise. Stability augmentation OFF.	C T & M		✓	✓	For periodic responses, record results for three full cycles (6 overshoots after input is completed) or that sufficient to determine time to one-half or double amplitude, whichever is less. The test may be terminated prior to 20 s if the test pilot determines that the results are becoming uncontrollably divergent. The response may be unrepeatable throughout the stated time for certain helicopters. In these cases, the test should show at least that a divergence is identifiable. For example: displacing the cyclic for a given time or until a given pitch attitude is achieved normally excites this test and then returning the cyclic to the original position. For non-periodic responses, results should show the same convergent or divergent character as the flight test data. <u>For G fidelity level</u>: The purpose of the test is to validate the dynamic characteristic of the model.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.c.	3b) Short-term response.	± 1.5° pitch angle or ± 2°/s pitch rate. ± 0.1 g normal acceleration.	Cruise or climb. Stability augmentation ON and OFF.	C T & M		✓	✓	Record results for at least two airspeeds. A control doublet inserted at the natural frequency of the aircraft normally excites this test. However, while input doublets are preferred over pulse inputs for augmentation-OFF tests, for augmentation-ON tests, when the short-term response exhibits first-order or deadbeat characteristics, longitudinal pulse inputs may produce a more coherent response. <u>For G fidelity level</u>: The purpose of the test is to validate the dynamic characteristic of the model. *Note 1.— A Doublet (Longitudinal) input may be generated by pulling back the pitch control sharply and holding input for 5 seconds, pushing forward the pitch control sharply and holding input for 5 seconds, and then release the pitch control to neutral position. Inputs should be large enough to produce ± 0.2 g load factor and/or ± 5 to 15 degree pitch attitude excursions.* *Note 2.— Deadbeat response to step commands is demonstrated by a system that rapidly reaches a stable state and holds that state with minimal overshoot.*
2.c.	4) Manoeuvring stability.	Longitudinal control position change from trim: ± 10% or ± 6.3 mm (0.25 in.); or longitudinal control force change from trim: ± 0.222 daN (0.5 lbf) or ± 10%.	Cruise or climb. Stability augmentation ON or OFF. Left and right turns.			✓	✓	Results should be recorded for two airspeeds to include minimum power required speed. For each airspeed condition the results should include roll angles at approximately 30° and 45°. The force may be shown as a cross plot for irreversible systems. This may be a series of snapshot tests.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.d.	**Lateral and directional handling qualities**							
2.d.	1) Control response.							The control response tests consist of the two tests 1a) and 1b) below.
2.d.	1a) Lateral.	Roll rate ± 10% or ± 3°/s. Roll attitude change ± 10% or ± 3°.	Cruise. Stability augmentation ON and OFF.	CT&M		✓	✓	Record results for at least two airspeeds, including the speed at or near the minimum power required airspeed. Record results for a step control input on the test axis. The off-axes response must show correct trend. Attitude change is defined as the attitude change from the value just before the step input. The tolerance is applied continuously from the step input time. <u>For G fidelity level</u>: The purpose of the test is to validate the dynamic characteristic of the model.
2.d.	1b) Directional.	Yaw rate ± 10% or ± 2°/s. Heading change ± 10% or ± 2°.	Cruise. Stability augmentation ON and OFF.	CT&M		✓	✓	Record results for at least two airspeeds, including the speed at or near the minimum power required airspeed. Record results for a step control input on the test axis. The off-axes response must show correct trend. Heading change is defined as the heading change from the value just before the step input. The tolerance is applied continuously from the step input time. <u>For G fidelity level</u>: The purpose of the test is to validate the dynamic characteristic of the model.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.d.	2) Directional static stability.	Roll attitude ± 1.5°. Vertical velocity ± 10% or ± 0.50 m/s (100 ft/min). Lateral control position change from trim: ± 10% or ± 6.3 mm (0.25 in.); or lateral control force change from trim: ± 10% or ± 0.222 daN (0.5 lbf). Directional control position change from trim: ± 10% or ± 6.3 mm (0.25 in.); or directional control force change from trim: ± 10% or ± 0.444 daN (1 lbf). Longitudinal control position change from trim: ± 10% or 6.3 mm (± 0.25 in.); or longitudinal control force change from trim: ± 10% or ± 0.222 daN (0.5 lbf).	Climb or descent. Stability augmentation ON or OFF.			✓	✓	Record results for at least two sideslip angles on either side of the trim point. The force may be shown as a cross plot for irreversible systems. This may be a series of snapshot tests. This is a steady heading sideslip test at a fixed collective position.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.d.	3) Dynamic lateral and directional stability.							The dynamic lateral and directional stability tests consist of the three tests 3a) to 3c) below.
2.d.	3a) Lateral-directional oscillations.	± 0.5 s or ± 10% of period. ± 10% of time to 1⁄2 or double amplitude or ± 0.02 of damping ratio. ± 20% or ± 1 s of time difference between peaks of bank and sideslip. For non-periodic responses, the time history must be matched over a 20 s period following release of the controls within: ± 5°/s of roll rate or ± 5° of roll attitude change; and ± 4°/s of yaw rate or ± 4° of heading.	Cruise or climb. Stability augmentation ON and OFF.	C T & M		✓	✓	Record results for at least two airspeeds. The test must be initiated with a cyclic or a pedal doublet input. Record results for six full cycles (12 overshoots after input is completed) or a number of cycles sufficient to determine time to one-half or double amplitude, whichever is less. The test may be terminated prior to 20 s if the test pilot determines that the results are becoming uncontrollably divergent.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
2.d.	3b) Spiral stability.	Correct trend and ± 2° or ± 10% of roll angle in 20 s. If alternate test is used: Lateral control position change from trim: ± 20% or ± 12.7 mm (0.5 in.).	Cruise or Climb. Stability augmentation ON and OFF.	C T & M		✓	✓	Record the results of turns for 20 s following a release from pedal-only or cyclic-only inputs. Results must be recorded from turns in both directions. Terminate the test at zero roll angle or when the test pilot determines that the attitude is becoming uncontrollably divergent. Aircraft data averaged from multiple tests may be used. Test for both directions. As an alternative test: record the results of the lateral cyclic input only (no pedal input) required to maintain a bank angle position of approximately 30 degrees from a steady flight trim. This may be a series of snapshot tests.
2.d.	3c) Adverse/proverse yaw.	Correct trend. ± 2° transient sideslip angle.	Cruise or climb. Stability augmentation ON and OFF. Stability augmentation ON case to include turn coordination system if available.			✓	✓	Record the time history of initial entry into cyclic-only turns, using only a moderate rate for cyclic input. Results must be recorded for turns in both directions.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
3.	**MOTION SYSTEM**							
3.a.	**Frequency response**	As specified by the applicant for FSTD qualification.	Not applicable.		✓	✓		An appropriate test to demonstrate the frequency response is required. See also paragraphs 3.5.2 and 3.5.3 of Part II, Appendix B.
3.b.	**Turnaround check**	As specified by the applicant for FSTD qualification.	Not applicable.		✓	✓		An appropriate test to demonstrate a smooth turnaround is required. See also paragraphs 3.5.2 and 3.5.4 of Part II, Appendix B.
3.c.	**Motion effects**							Refer to Appendix C to this Part on subjective testing.
3.d.	**Motion system repeatability**	± 0.05 g actual platform linear accelerations.	None.		✓	✓		This test ensures that the motion system hardware and software (in normal FSTD operating mode) continue to perform as originally qualified. Performance changes from the original baseline can be readily identified with this information. See paragraph 3.5.5 of Part II, Appendix B.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
3.e.	**Motion cueing fidelity**							Appropriate testing criterion and tolerances are currently being tested and evaluated through the ICFQ mechanism (refer to Appendix D of Part II).
3.e	1) Motion cueing fidelity – Frequency – domain criterion.	To be defined.	Ground and in flight.		✓	✓		For the motion system as applied during training, record the combined modulus and phase of the motion cueing algorithm and motion platform over the frequency range appropriate to the characteristics of the helicopter being simulated. This test is only required during the initial FSTD qualification. See paragraph 3.5.6.1 of Part II, Appendix B.
3.e	2) Motion cueing fidelity – Time – domain criterion.	To be defined.	Ground and in flight.		✓	✓		See paragraph 3.5.6.2 of Part II, Appendix B.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
3bis.	**VIBRATIONS**							
3bis. a.	**Characteristic motion vibration.**	None.	Ground and flight.					The following tests with recorded results and an SOC are required for characteristic motion vibrations, which can be sensed in the cockpit where applicable for the helicopter type. Vibrations tests results to include 1/Rev and n/Rev vibrations where n is the number of rotor blades. *Note.— "n/Rev" means a vibration test for the frequency equal to n times the rotor RPM.* The recorded test results for characteristic buffets should allow the comparison of relative amplitude versus frequency. Tests are required with recorded results which allow the comparison of relative amplitudes versus frequency in the longitudinal, lateral and vertical axes with helicopter data. Steady state tests are acceptable. For R fidelity level, only footprint test results are required. Where initial evaluation employs approved subjective tuning to develop the approved reference standard, tolerances should be used during recurrent evaluations.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
3bis. a.	1) Ground.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test.	Ground.			✓	✓	Tests to demonstrate the normal vibration level with helicopter on the ground, all engines operating at normal idle and flight power settings. Two tests conditions are required: 1) engine(s) control(s) on “Idle” power setting and corresponding N_R condition; and 2) engine(s) control(s) on “Flight” power setting and corresponding N_R condition.
3bis. a.	2) Hover (IGE).	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Hover.			✓	✓	Test to demonstrate the normal vibration level with helicopter in hover condition IGE.
3bis. a.	3) Hover (OGE).	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Hover.			✓	✓	Test to demonstrate the normal vibration level with helicopter in hover condition OGE.
3bis. a.	4) Normal climb.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Climb.			✓	✓	Test to demonstrate the normal vibration level with helicopter in normal climb at normal climb speed, all engines operating.
3bis. a.	5) Vertical climb.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Climb.			✓	✓	Test to demonstrate the normal vibration level with helicopter in vertical climb from a hover condition.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
3bis. a.	6) Level flight at low speed.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Cruise.			✓	✓	Test to demonstrate the normal vibration level with helicopter in forward translational level flight around V_y.
3bis. a.	7) Level flight at cruise speed.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Cruise.			✓	✓	Test to demonstrate the normal vibration level with helicopter in flight at normal cruise speed.
3bis. a.	8) Level flight at high speed.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Cruise.			✓	✓	Test to demonstrate the normal vibration level with helicopter in flight at high speed (near or at V_{ne}).
3bis. a.	9) Descent.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Descent.			✓	✓	Test to demonstrate the normal vibration level with helicopter in normal powered descent at normal speed, all engines operating.
3bis. a.	10) Autorotation.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test).	Autorotation.			✓	✓	Test to demonstrate the normal vibration level with helicopter in autorotation descent, all engines inoperative (or at least at idle), nominal main rotor RPM and recommended autorotation speed.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
3bis. a.	11) Steady state turns.	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend (see general comment for the 3bis.a test)	Cruise.			✓	✓	Test to demonstrate the normal vibration level with helicopter in stabilized turn at various bank angles; at least two conditions are to be demonstrated (for instance for a standard rate of turn and a higher bank angle of around 45° in order to demonstrate the effect of rotor disk load on vibration level, if any).
3bis. b.	**Special conditions.**	+ 3 db / - 6 db or ± 10% of nominal vibration level and correct trend.	Ground and in flight.				✓	This applies to special steady-state cases identified as particularly significant to the pilot, important in training, or unique to a specific helicopter type or model. This may include effect of landing gear, icing effect, vortex ring state (settling with power), atmospheric disturbance and all relevant vibration cues due to normal and abnormal operations of the rotor and transmission system. The recorded test results for characteristic buffets should allow the comparison of relative amplitude versus frequency. An SOC is required. Tests are required with recorded results that allow the comparison of relative amplitudes versus frequency in the longitudinal, lateral and vertical axes with helicopter data. Steady state tests are acceptable. Where initial evaluation employs approved subjective tuning to develop the approved reference standard, tolerances should be used during recurrent evaluations. For atmospheric disturbance, general purpose models are acceptable which approximate demonstrable flight test data.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
4.	**VISUAL SYSTEM**							
4.a.	**Visual scene quality**							
4.a.1	Continuous field of view.	Visual display providing each pilot simultaneously with a minimum of 210° horizontal and 60° vertical continuous field of view. With the image centred on the helicopter centreline the offset from each pilot's eye position should not exceed 10 degrees inboard.	Not applicable.				✓	The field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of 5° squares. Installed alignment should be confirmed in an SOC (this would generally be results from acceptance testing). The 10 degrees limitation may be extended to 12 degrees where practical considerations, such as dome size on large dual cockpit helicopters, make the increase necessary, provided that the FSTD operator can prove to the satisfaction of the qualifying authority that the quality of training will not be compromised.
	Continuous field of view, but a reduced field of view is acceptable in accordance with the intended use of the device.	Visual display providing each pilot simultaneously with a minimum of 180° horizontal and 45° vertical continuous field of view or reduced field of view as agreed for the device. With the image centred on the helicopter centreline the offset from each pilot's eye position should not exceed 10 degrees inboard.	Not applicable.			✓		Field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of 5° squares. Installed alignment and agreed field of view should be confirmed in an SOC (this would generally be results from acceptance testing).

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
(ctd) 4.a.1	Display field of view.	Visual field of view for each pilot of a minimum of 45° horizontally and 30° vertically, unless restricted by the type of helicopter, simultaneously for each pilot. With the image centred on the helicopter centreline the offset from each pilot eye position should not exceed 10 degrees inboard.	Not applicable.	✓				The minimum distance from the pilot's eye position to the surface of a direct view display may not be less than the distance to any front panel instrument. A 30° vertical field of view may be insufficient to meet the requirements of the visual ground segment (if required). This needs to be considered in the FOV calculation. The 10 degrees limitation may be extended to 12 degrees where practical considerations, such as dome size on large dual cockpit helicopters, make the increase necessary, provided that the FSTD operator can prove to the satisfaction of the qualifying authority that the quality of training will not be compromised.
4.a.2. a.1	System geometry — Image position.	From each eyepoint position, the centre of the image is between 0° and 2° inboard in the horizontal plane with the image centred on the helicopter centreline and within ± 0.25° vertically <u>for collimated displays</u>. <u>For real image displays</u>, from each eyepoint position, the centre of the image is between 0° and 10° inboard in the horizontal plane with the image centred on the helicopter centreline and within ±0.25° vertically and ±0.5° horizontally.	Not applicable.			✓	✓	The image position should be checked relative to the FSTD centreline. Where there is a design offset in the vertical display centre this should be stated.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
4.a.2.a.2	System geometry — Absolute geometry.	Within the specified minimum FOV all points on a 5° grid should fall within 3° of the design position as measured from each pilot eyepoint, when the image is aligned with the relevant eyepoint.	Not applicable.			✓	✓	Where a system with more than the minimum FOV is supplied, the geometry outside the central area should not have any distracting discontinuities.
4.a.2.a.3	System geometry — Relative geometry.	Measurements of relative dot positions should be made every 5 degrees. In the area from -10° to the lowest visible point, at 15° azimuth inboard, 0°, 30°, 60° and 85° azimuth outboard for each pilot position, vertical measurements should be made every 1° to the edge of the visible image. The relative position from one point to the next should not exceed within: Zone 1 : 0.075°/degree; Zone 2 : 0.15°/degree; and Zone 3 : 0.2°/degree.	Not applicable.			✓	✓	For a diagram showing Zones 1, 2 and 3 and further discussion of this test, see paragraph 3.6.3.3 of Part II, Appendix B. *Note,– A means to perform this check with a simple go/no go gauge is encouraged for recurrent testing.*

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
4.a.2.b		Geometry of image should have no distracting discontinuities.		✓				
4.a.3	Surface resolution (object detection).	Not greater than 2 arc minutes.	Not applicable				✓	Resolution will be demonstrated by a test of objects shown to occupy the required visual angle in each visual display used on a scene from the pilot's eyepoint. The object will subtend 2 arc minutes to the eye. This may be demonstrated using threshold bars for a horizontal test. A vertical test should also be demonstrated. The subtended angles should be confirmed by calculations in an SOC.
	Surface resolution (object detection).	Not greater than 3 arc minutes.	Not applicable.			✓		Resolution will be demonstrated by a test of objects shown to occupy the required visual angle in each visual display used on a scene from the pilot's eyepoint. The object will subtend 3 arc minutes to the eye. This may be demonstrated using threshold bars for a horizontal test. A vertical test should also be demonstrated. The subtended angles should be confirmed by calculations in an SOC.
	Surface resolution (object detection).	Not greater than 4 arc minutes.	Not applicable.	✓				Resolution will be demonstrated by a test of objects shown to occupy the required visual angle in each visual display used on a scene from the pilot's eyepoint. The object will subtend 4 arc minutes to the eye. This may be demonstrated using threshold bars for a horizontal test. A vertical test should also be demonstrated. The subtended angles should be confirmed by calculations in an SOC.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
4.a.4	Light-point size.	Not greater than 5 arc minutes.	Not applicable.				✓	Light-point size should be measured using a test pattern consisting of a single row of light-points displayed as both a horizontal and vertical row. It should be possible to move the light-points relative to the eyepoint in all axes. At a point where modulation is just discernible in each visual channel a calculation should be made to determine the light spacing. An SOC is required to state test method and calculation.
	Light-point size.	Not greater than 8 arc minutes.	Not applicable.	✓		✓		
4.a.5	Raster surface contrast ratio.	Not less than 8:1.	Not applicable.				✓	Surface contrast ratio should be measured using a raster drawn test pattern filling the entire visual scene (all channels). The test pattern should consist of black and white squares, of not more than 10° per square, with a white square in the centre of each channel. Measurements should be made of the bright squares using a 1° spot photometer and the average calculated. This value should have a minimum brightness of 7 cd/m^2 (2 ft-lamberts). Measure the dark squares. The contrast ratio is the average of the bright square value divided by the average of the dark square value. *Note 1.— During contrast ratio testing, FSTD aft cabin and cockpit ambient light levels should be as low as possible.* *Note 2.— Measurements should be taken at the centre of squares to avoid light spill into the measurement device.*

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
	Raster surface contrast ratio.	Not less than 5:1.	Not applicable.			✓		Surface contrast ratio should be measured using a raster drawn test pattern filling the entire visual scene (all channels). The test pattern should consist of black and white squares, 5° per square with a white square in the centre of each channel. Measurement should be made on the centre bright square for each channel using a 1° spot photometer. This value should have a minimum brightness of 7 cd/m^2 (2 ft-lamberts). Measure any adjacent dark squares. The contrast ratio is the bright square value divided by the dark square value. *Note 1.— During contrast ratio testing, FSTD aft cabin and cockpit ambient light levels should be as low as possible.* *Note 2.— Measurements should be taken at the centre of squares to avoid light spill into the measurement device.*
	Raster surface contrast ratio.	Not less than 4:1.	Not applicable.	✓				
4.a.6	Light-point contrast ratio.	Not less than 25:1.	Not applicable.				✓	Light-point contrast ratio should be measured using a test pattern demonstrating an area of greater than 1° area filled with white light-points and should be compared to the adjacent background. *Note.— Light-point modulation should be just discernible on calligraphic systems but will not be discernable on raster systems.* Measurements of the background should be taken such that the bright square is just out of the light meter FOV. *Note.— During contrast ratio testing, FSTD aft cabin and cockpit ambient light levels should be as low as practical.*
	Light-point contrast ratio.	Not less than 10:1.	Not applicable.			✓		
	Light-point contrast ratio.	Not less than 8:1.	Not applicable.	✓				

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
4.a.7	Light-point brightness.	Not less than 30 cd/m^2 (8.5 ft-lamberts).	Not applicable.				✓	Light-points should be displayed as a matrix creating a square.
	Light-point brightness.	Not less than 20 cd/m^2 (5.8 ft-lamberts).	Not applicable.			✓		On calligraphic systems the light-points should just merge. On raster systems the light-points should overlap such that the square is continuous. (Individual light-points will not be visible.)
4.a.8	Surface brightness.	Not less than 20 cd/m^2 (5.8 ft-lamberts) on the display.	Not applicable.				✓	Surface brightness should be measured on a white raster and measuring the brightness using the 1° spot photometer.
	Surface brightness.	Not less than 14 cd/m^2 (4.1 ft-lamberts) on the display.	Not applicable.			✓		Light-points are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable.
4.a.9	Black level and sequential contrast.	Black intensity: Black polygon brightness – ambient brightness < 0.015 cd/m^2 (0.004 ft-lamberts). Sequential contrast: White polygon brightness/ (black polygon brightness – ambient brightness) >2 000:1.	Not applicable.			✓	✓	The light meter should be mounted in a fixed position viewing the forward centre area of each display. All projectors should be turned off and the cockpit environment made as dark as possible. A reading should be taken of the remaining ambient light on the screen. The projectors should then be turned on and a black polygon displayed. A second reading should then be taken and the difference between this and the ambient level recorded. A full brightness white polygon should then be measured for the sequential contrast test. This test is generally only required for **light valve projectors**. An SOC should be provided if the test is not run, stating why.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
4.a. 10	Motion blur.	Modulation between white squares should be visible on gaps of 3 arc min or less when the pattern is rotated at 10°/s.	Not applicable.			✓	✓	A test pattern consisting of an array of five peak white squares with black gaps between them of decreasing width. The range of black gap widths should at least extend above and below the required detectable gap, and be in steps of 1 arc min. The peak white squares should be four times wider than the black gap width to avoid temporal aliasing. The pattern is rotated at the required rate. Two arrays of squares should be provided, one rotating in heading and the other in pitch, to provide testing in both axes. A series of stationary numbers identifies the size of the gaps. *Note.— This test can be limited by the display technology. Where this is the case the NAA should be consulted on the limitations.* This test is generally only required for **light valve projectors**. An SOC should be provided if the test is not run, stating why.
4.a. 11	Speckle test.	Speckle contrast should be <10%.	Not applicable.				✓	An SOC is required describing the test method. This test is generally only required for **laser projectors**. An SOC should be provided if the test is not run stating why.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
4.a. 12	Black level in stimulated NVG training (Type 3 EFVS device only (refer to Attachment L to Part II)).	Black polygon brightness <= 0.001 cd/m² (0.0003 ft-lambert).	Not applicable.			✓	✓	The test should be conducted with the visible OTW image projectors operating normally. The IR projectors should be turned off for this test. In cases where only one projector system is used for the OTW and the NVG image stimulation, the test should be conducted with this projector in NVG mode, i.e. with appropriate filtering. The light meter should be mounted in a fixed position viewing the forward centre area of each display. All projectors should be turned off and the cockpit environment made as dark as possible. A reading should be taken of the remaining ambient light on the screen. The OTW projectors should then be turned on and a black polygon displayed, a second reading should then be taken and the difference between this and the ambient level recorded.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
4.a.13	Light-point brightness in stimulated NVG training (Type 3 EFVS device only (refer to Attachment L to Part II)).	Not less than 10 cd/m^2 (2.9 ft-lamberts).	Not applicable.			✓	✓	The test should be conducted with the IR projectors operating normally. The visible OTW image projectors should be turned off for this test. In cases where only one projector system is used for the OTW and the NVG image stimulation, the test should be conducted with this projector in NVG mode, i.e. with appropriate filtering. Light-points should be displayed as a matrix creating a square. On calligraphic systems the light-points should just merge. On raster systems the light-points should overlap such that the square is continuous (individual lights will not be visible).
4.b	**Head-Up Display (HUD)**							
4.b.1	Static alignment.	Static alignment with displayed image. HUD bore sight should align with the centre of the displayed image spherical pattern. Tolerance ± 6 arc min.				✓	✓	Alignment applies to the pilot flying only.
4.b.2	System display.	All functionality in all flight modes should be demonstrated.				✓	✓	A statement of the system capabilities should be provided and the capabilities demonstrated.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
4.b.3	HUD attitude vs FSTD attitude indicator (pitch and roll of horizon).	Pitch and roll align with the helicopter instruments and OTW display. Tolerance ± 1°.	In flight.			✓	✓	Alignment applies to the pilot flying only.
4.c	**Enhanced flight vision system (EFVS)**							
4.c.1	Registration test.	Alignment between EFVS display and OTW image should represent the alignment typical of the helicopter and system type.	Take-off point and on approach at 61 m (200 ft) AGL.			✓	✓	*Note.— The effects of the alignment tolerance in 4.b.1 should be taken into account.*
	Registration test.	Alignment between EFVS display and OTW image should represent the alignment typical of the helicopter and system type.	Take-off point and on approach at 61 m (200 ft) AGL.			✓	✓	Alignment applies to the pilot flying only. *Note.— The effects of the alignment tolerance in 4.b.1 should be taken into account.*
4.c.2	EFVS RVR and visibility calibration.	The scene represents the EFVS view at 350 m (1 200 ft) and 1 600 m (1 sm) RVR including correct light intensity.	In flight.			✓	✓	IR scene representative of both 350 m (1 200 ft), and 1 600 m (1 sm). Visual scene may be removed.
4.c.3	Thermal crossover.	Demonstrate thermal crossover effects during day to night transition.	Day and night.			✓	✓	The scene will correctly represent the thermal characteristics of the scene during a day to night transition.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
4.d	**Visual ground segment**							
4.d.1	Visual ground segment. This test applies only to helicopters equipped with ILS. Where the straight ahead down view of the helicopter exceeds the display system downward FOV, the display down view angle should be used for the test.	Near end: the correct number of approach lights within the computed VGS should be visible. Far end: ± 20% of the computed VGS. Where the threshold lights are computed to be visible they should be visible in the FSTD.	Trimmed in the landing configuration at 30 m (100 ft) wheel/skid height above touchdown zone on glide slope at an RVR setting of 300 m (1 000 ft) or 350 m (1 200 ft).			✓	✓	This test is designed to assess items impacting the accuracy of the visual scene presented to a pilot at DH on an ILS approach. These items include: 1) RVR/visibility; 2) glide slope (G/S) and localizer modelling accuracy (location and slope) for an ILS; 3) for a given mass, configuration and speed representative of a point within the helicopter's operational envelope for a normal approach and landing; and 4) radio altimeter. For non type-specific devices, a cut-off angle typical of the group of helicopters should be used. *Note.— If non-homogenous fog is used, the vertical variation in horizontal visibility should be described and included in the slant range visibility calculation used in the VGS computation.*

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
4.e	**Visual system scene content**							
4.e.1	System content — Day, dusk and night.	Not less than: 10 000 visible textured surfaces, 5 000 light-points, 16 moving models.	Not applicable.				✓	Demonstrated through use of a visual scene rendered with the same image generator modes used to produce scenes for training. The required surfaces, light-points, and moving models should be displayed simultaneously. The stated capacity should be available in all time of day conditions.
4.e.2	System content — Day, dusk and night.	Not less than: 6 000 visible textured surfaces, 5 000 light-points, 16 moving models.	Not applicable.			✓		Demonstrated through use of a visual scene rendered with the same image generator modes used to produce scenes for training. The required surfaces, light-points, and moving models should be displayed simultaneously. The stated capacity should be available in all time of day conditions.
4.e.3	System content — Day, dusk and night.	Not less than: 6 000 visible textured surfaces, 1 000 light-points.	Not applicable.	✓				

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
5.	**SOUND SYSTEM**							Sound tests with R fidelity level have been divided into three sub-categories: RA – which covers: (TP): TR, RL, OS. RB – which covers: (T): TR, RL, OS; and (TP): Malfunctions. RC – which covers: (T): Malfunctions. The following table will refer to RA, RB and RC for convenience.
5.a	**Basic requirements**							All tests in sub-category levels RA and RB of this section should be presented using an unweighted 1/3 octave band format from at least band 17 to 42 (50 Hz to 16 kHz). A measurement of minimum 20 s should be taken, when possible, at the location corresponding to the approved data set. The approved data set and FSTD results should be produced using comparable data analysis techniques. Refer to paragraph 3.7 of Appendix B to Part II. For level RC, tests in this section may be presented as a single overall SPL level.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
5.a.	1) Ready for engine start.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Ground.			✓ RA		Normal condition prior to engine start. The APU should be on if appropriate. For level RA: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For level RA: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.				✓ RB		
		(ctd on next page)						

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		
5.a.	2) All engines operating at normal idle power setting; a) rotor not turning (if applicable); and b) rotor turning.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Ground.			✓ RA		<u>For level RA</u>: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. <u>For level RA</u>: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and				✓ RB		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
		the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.						
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		
5.a.	3) All engines operating at normal flight power setting.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Ground.			✓ RA		Normal condition prior to lift-off. For level RA: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For level RA: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.				✓ RB		
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
5.a.	4) Hover; a) IGE; and b) OGE.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Hover.			✓ RA		For level RA: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For level RA: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.				✓ RB		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		
5.a.	5) Climb.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	En-route climb.			✓ RA		Medium altitude. For level RA: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For level RA: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and				✓ RB		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
		the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.						
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		
5.a.	6) Cruise.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Cruise.			✓ RA		Normal cruise configuration. <u>For level RA</u>: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. <u>For level RA</u>: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands.				✓ RB		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
		Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.						
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		
5.a.	7) Steady state turn.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Cruise.			✓ RA		30 to 45° bank angle. For level RA: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For level RA: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.				✓ RB		
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		
5.a.	8) Autorotation.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the	Autorotation in steady descent.			✓ RA		Normal operating RPM. For level RA: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct.

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
		absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.						For level RA: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.				✓ RB		
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
5.a.	9) Final approach.	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.	Landing.			✓ RA		Constant airspeed. For level RA: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For level RA: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.				✓ RB		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		
5.b	**Special cases**	Initial evaluation: ± 5 dB per 1/3 octave band. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.				✓ RA		This applies to special steady-state cases identified as particularly significant to the pilot, important in training, or unique to a specific helicopter type or model. <u>For level RA</u>: it would be acceptable to have some 1/3 octave bands out of the ± 5 dB tolerance but not more than two that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. <u>For level RA</u>: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations. All level RA and RB tests in this section should be presented using an unweighted 1/3 octave band format from at least bands 17 to 42 (50 Hz to 16 kHz).
		Initial evaluation: subjective assessment of 1/3 octave bands. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and				✓ RB		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
		the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.						A measurement of minimum 20 s should be taken, when possible, at the location corresponding to the approved data set. The approved data set and FSTD results should be produced using comparable data analysis techniques. Refer to paragraph 3.7 of Appendix B to Part II. <u>For level RC</u>: Tests in this section may be presented as a single overall SPL level.
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		
5.c	**FSTD background noise**	Initial evaluation: background noise levels should fall below the plot in Figure B-6 of Appendix B to Part II. Recurrent evaluation: ± 3 dB per 1/3 octave band compared to initial evaluation.				✓ RA RB		Results of the background noise at initial qualification should be included in the QTG document and approved by the qualifying NAA. The simulated sound will be evaluated to ensure that the background noise does not interfere with training. Refer to paragraph 3.7.7 of Appendix B to Part II. The measurements are to be made with the simulation running, the sound muted and a dead cockpit. For levels RA and RB, this test should be presented using an unweighted 1/3 octave band format from band 17 to 42 (50 Hz to 16 kHz). For level RC, this test may be presented as a single overall SPL level.
		Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
5.d	**Frequency response**	Initial evaluation: not applicable. Recurrent evaluation: cannot exceed ± 5 dB difference on three consecutive bands when compared to initial evaluation and the average of the absolute differences between initial and recurrent evaluation results cannot exceed 2 dB.				✓ RA RB		Only required if the results are to be used during recurrent evaluations according to paragraph 3.7.8 of Appendix B to Part II. The results should be acknowledged by the NAA during the initial qualification. For levels RA and RB, this test should be presented using an unweighted 1/3 octave band format from band 17 to 42 (50 Hz to 16 kHz). For level RC, this test should be run at three frequencies (high, mid-range and low).
		Initial evaluation: not applicable. Recurrent evaluation: ± 3 dB SPL RMS compared to initial evaluation.				✓ RC		

	TEST	TOLERANCE	FLIGHT CONDITION	G	R1	R	S	COMMENTS
6	**SYSTEMS INTEGRATION**							
6.a	**System response time**							
6.a.	1) Transport delay.	85 ms or less after controller movement.	Pitch, roll and yaw.				✓	One separate test is required in each axis.
		120 ms or less after controller movement.		✓		✓		Where EFVS systems are installed, the EFVS response should be within ± 30 ms from visual system response, and not before motion system response. *Note.— The delay from the helicopter EFVS electronic elements should be added to the 30 ms tolerance before comparison with the visual system reference as described in Attachment G to Part II.*

Appendix C

FUNCTIONS AND SUBJECTIVE TESTS

1. INTRODUCTION

1.1 Accurate replication of helicopter systems functions should be checked at each flight crew member position. This includes procedures using the RFM and checklists. Handling qualities, performance and FSTD systems operation, as they pertain to the actual helicopter, as well as FSTD cueing (e.g. visual, motion cueing) and other supporting systems (e.g. IOS), should be subjectively assessed. Prior coordination with the NAA responsible for the evaluation is essential to ensure that the functions tests are conducted in an efficient and timely manner and that any skills, experience or expertise required by the evaluation team are available.

1.2 The necessity of functions and subjective tests arises from the need to confirm that the simulation has produced a totally integrated and acceptable replication of the helicopter. Unlike the objective tests listed in Appendix B to this Part, the subjective testing should cover those areas of the flight envelope that may reasonably be reached by a trainee. Like the validation tests, the functions and subjective tests conducted during the initial evaluation are only a "spot check" and not a rigorous examination of the quality of the simulation in all areas of flight and systems operation. The operator should have completed the acceptance testing of the FSTD with support from the FSTD manufacturer prior to the device being submitted for the initial evaluation to be conducted by the NAA evaluator(s).

1.3 At the request of an operator, the FSTD may be assessed for a special aspect of a relevant training programme during the functions and subjective portion of an evaluation. Such an assessment may include a portion of a LOFT (line-oriented flight training) scenario, an operator/mission specific scenario or special emphasis items in the training programme. Unless directly related to a requirement for the current qualification type, the results of such an evaluation would not affect the FSTD's current status.

1.4 Functions tests should be run in a logical flight sequence at the same time as performance and handling assessments. This also permits the FSTD to run for two to three hours in real time, without repositioning of flight or position freeze, thereby permitting proof of reliability.

1.5 The FSTD should be assessed to ensure that repositions, resets and freezes support efficient and effective training.

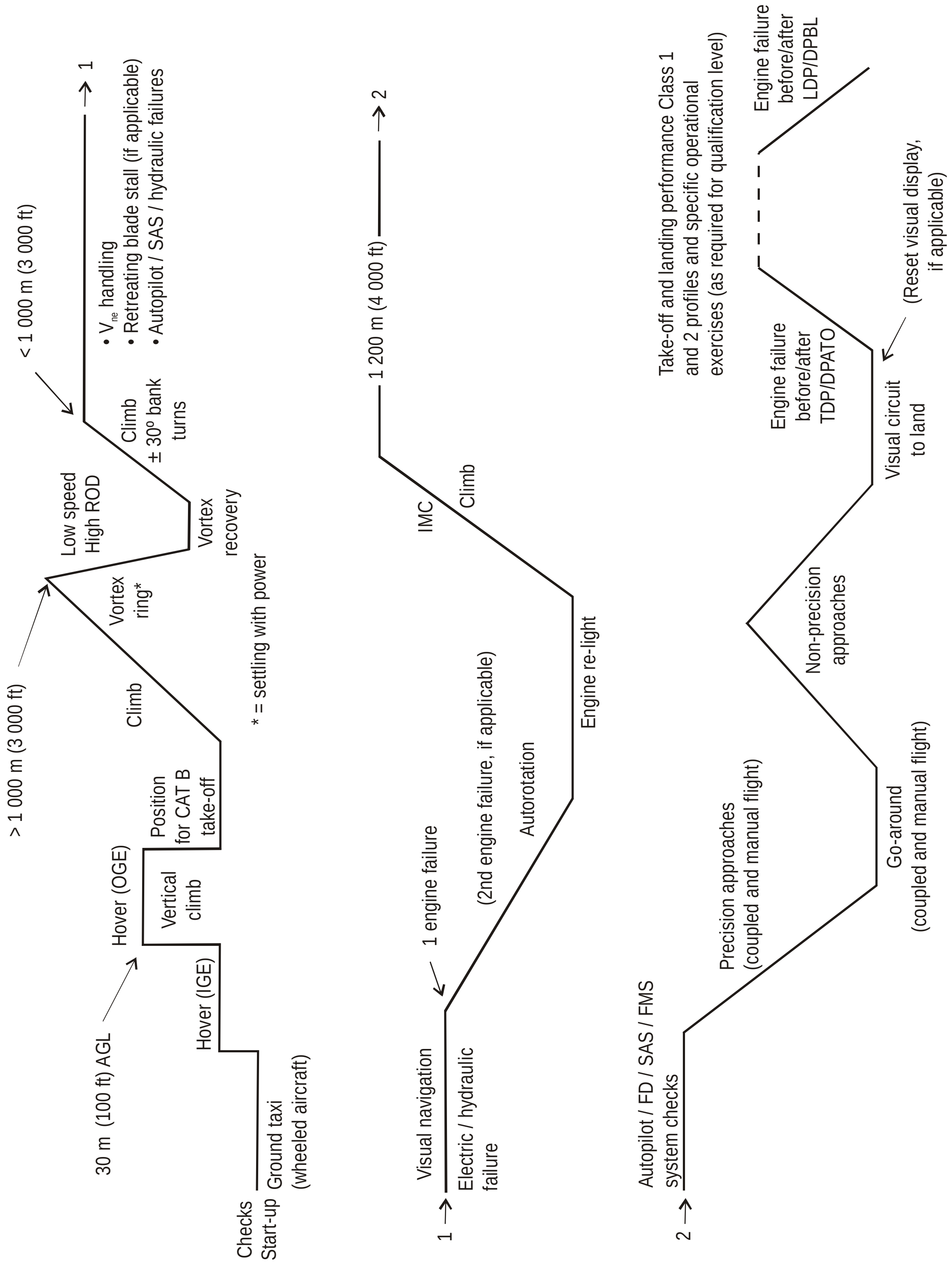
1.6 The FSTD should be assessed to ensure that ATC environment simulation supports efficient and effective training.

2. TEST REQUIREMENTS

2.1 The ground and flight tests and other checks required for qualification are listed in the following Table of Functions and Subjective Tests. The table includes manoeuvres and procedures to ensure that the FSTD functions and performs appropriately for use in pilot training, testing and checking in the manoeuvres and procedures normally required of an approved training programme. It is understood that if a particular ground or flight test or other required check is not applicable to the helicopter being simulated or the operator's area of operations, the test or check is not required. There should not be any negative training aspects associated with any manoeuvre or procedure identified for any FSTD type for which several of the FSTD features are at a fidelity level of "R" or "G".

2.2 A representative selection of systems functions should be assessed for normal and, where appropriate, alternate operations. Normal, abnormal and emergency procedures associated with a flight phase should be assessed during the evaluation of manoeuvres or events within that flight phase. The effects of the selected malfunctions should be sufficient to correctly exercise the helicopter related procedures and checklists. Systems are listed separately under "any flight phase" to ensure appropriate attention to systems checks.

2.3 A typical Functions and Subjective Test Profile is shown below:


Checks
Start-up
Ground taxi
(wheeled aircraft)
30 m (100 ft) AGL
Hover (IGE)
Hover (OGE)
Vertical
climb
Position
for CAT B
take-off
> 1 000 m (3 000 ft)
Climb
Vortex
ring*
Low speed
High ROD
Vortex
recovery
* = settling with power
Climb
± 30° bank
turns
< 1 000 m (3 000 ft)
• V_{ne} handling
• Retreating blade stall (if applicable)
• Autopilot / SAS / hydraulic failures
→ 1
1 →
Visual navigation
Electric / hydraulic
failure
1 engine failure
(2nd engine failure, if applicable)
Autorotation
Engine re-light
Climb
IMC
1 200 m (4 000 ft)
→ 2
2 →
Autopilot / FD / SAS / FMS
system checks
Precision approaches
(coupled and manual flight)
Go-around
(coupled and manual flight)
Non-precision
approaches
Visual circuit
to land
Engine failure
before/after
TDP/DPATO
(Reset visual display,
if applicable)
Engine failure
before/after
LDP/DPBL
Take-off and landing performance Class 1
and 2 profiles and specific operational
exercises (as required for qualification level)

3. TABLE OF FUNCTIONS AND SUBJECTIVE TESTS

Note 1.— The Functions and Subjective Tests are all executed in an environment where FSTD features are used in a fully integrated manner. The integrated nature of the testing environment prevents these functions and subjective tests from being classified by feature fidelity level. Where any new type of FSTD is created, it will inevitably have a collection of different feature fidelity levels in its construction, which precludes the possibility of classifying tests for those "device types" using the categories G, R and S. To avoid the possibility of confusion by associating function and subjective tests for those "device types" with G, R and S, the feature fidelity levels are not presented in this table. Instead, the complete Functions and Subjective Tests list as used in Part II, Appendix C of this Volume is provided with a single blank column under the heading "Applicability". For any new device type created, an appropriate Functions and Subjective Tests list will have to be defined from this master list. This should be done by analysis of the applicable training tasks that the device will support as presented in Part I of this Volume and by entering ticks in the "Applicability" column for appropriate test cases. This list will have to be agreed to with the relevant NAA. Examples of this can be seen in Part II, Appendix C of this volume where similar exercises were conducted for device Types I to V.

Note 2.— The special needs for a more sophisticated Air Traffic Control (ATC) environment simulation system in accordance with paragraph 13 of Appendix A to this Part apply to some types of training, testing and checking and this should be accounted for when producing the test list.

Note 3.— "Other" means any other test, as applicable to the simulated helicopter and as applicable to the FSTD type.

Number	Functions and Subjective Tests	Applicability
		Yes / No
1	**Preparation for flight.**	
1.a	Functional check. Accomplish a functions check of all switches, indicators, systems, and equipment at all crew members' and instructors' stations and determine that:	
1.a.1	The cockpit design and functions are identical to that of the helicopter.	
1.a.2	The cockpit design and functions are representative of the group of helicopter.	
1.a.3	The ambient lighting provides an even level of illumination and is not distracting to the flight crew members.	
2	**Surface operations (pre-take-off).**	
2.a	APU/Engine start and run-up. *Note.— After start checks but no before start checks or programming or navigation aids and communication setups.*	
2.a.1	Normal start.	
2.a.2	Alternate start procedures.	

Number	Functions and Subjective Tests	Applicability Yes / No
2.a.3	Abnormal starts and shutdowns (hot start, hung start, fire, etc.).	
2.a.4	Rotor start/engagement and acceleration, disengagement and deceleration.	
2.a.4.a	Rotor start/engagement and acceleration.	
2.a.4.b	Rotor disengagement and deceleration (needles split).	
2.a.4.c	Ground resonance (if applicable on type).	
2.a.4.d	Icy/slippery surface.	
2.a.5	After start systems checks (e.g. electrical, hydraulic, flight controls, autopilot, radios, lighting systems).	
2.b	Taxi — Ground.	
2.b.1	Collective lever/cyclic friction setting.	
2.b.2	Power required to taxi/cyclic input.	
2.b.3	Brakes operation (effectiveness/failure).	
2.b.4	Ground handling.	
2.b.5	Water taxi/handling/floats.	
2.b.6	Tail/nosewheel lock operation.	
2.b.7	Minimum radius turn.	
2.b.8	Taxi aids (e.g. moving map).	
2.b.9	Surface contaminants (water, snow, ice, sand, etc.).	
2.b.10	Surface roughness.	
2.b.11	Surface type (hard, soft, etc.).	
2.b.12	Other.	
2.c	Taxi — Hover/air/transit/translational flight.	
2.c.1	Lift-off characteristics with and without wind.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
2.c.2	Hover characteristics, engine and flight instruments response. *Note.— Hovering modes should include SAS ON and OFF, height stability ON and OFF, cyclic trim ON and OFF.*	
2.c.2.a	In ground effect (IGE).	
2.c.2.b	Out of ground effect (OGE).	
2.c.2.c	With and without wind.	
2.c.3	Hover power check.	
2.c.3.a	In ground effect (IGE).	
2.c.3.b	Out of ground effect (OGE).	
2.c.4	Hover turns (around a spot, about the nose/tail).	
2.c.5	Anti-torque/directional control effect.	
2.c.6	Translating tendency.	
2.c.7	No wind/headwind/crosswind/tailwind hover.	
2.c.8	Critical azimuth.	
2.c.9	Air taxi/transit/translational flight (forward, sideward, rearward).	
3	**Take-off and departure.**	
3.a	Normal.	
3.a.1	From ground.	
3.a.2	From hover.	
3.a.2.a	CAT A and/or PC1/PC2 for all certified profiles.	
3.a.2.b	CAT B or PC3.	
3.b	Running.	
3.c	Crosswind/tailwind.	
3.d	Maximum performance.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
3.e	MCTM.	
3.f	Instrument.	
3.g	Confined area.	
3.h	Slope.	
3.i	Obstacle clearance.	
3.j	Elevated heliport/helideck/pinnacle/platform.	
3.k	Vertical.	
3.l	High altitude.	
3.m	Take-off in snow, sand, dust.	
3.n	Transition into forward flight.	
3.o	Abnormal/emergency procedure during take-off and departure.	
3.o.1	Engine failure.	
3.o.2	Rejected take-off/forced landing.	
3.o.2.a	Over land.	
3.o.2.b	Over water.	
3.o.3	CAT A and/or PC1/PC2.	
3.o.3.a	Engine failure prior to TDP.	
3.o.3.b	Engine failure at or after TDP.	
3.p	Instrument departure.	
3.q	Other.	
4	**Climb.**	
4.a	Normal.	
4.b	Obstacle clearance.	
4.c	Best rate.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
4.d	Best angle.	
4.e	Vertical climb.	
4.f	One (or more) engine(s) inoperative.	
4.g	Level-off.	
4.h	CAT A and/or PC1/PC2 operation for all certified profiles with engine failure up to 300 m (1 000 ft) above heliport elevation.	
4.i	Other.	
5	**Cruise.**	
5.a	Performance characteristics and flying qualities.	
5.a.1	Straight and level flight.	
5.a.2	Low speed flight (not below ETL speed).	
5.a.3	Accelerations and decelerations.	
5.a.4	High speed vibrations.	
5.a.5	High speed warnings.	
5.a.6	Turns.	
5.a.6.a	Normal.	
5.a.6.b	Standard rates (rate ½, 1 and 2).	
5.a.6.c	Steep (30 and 45° of bank).	
5.a.6.d	Flight controls servo actuator transparency effects.	
5.b	En-route navigation.	
5.b.1	Terrain accuracy for forced landing area selection.	
5.b.2	Terrain accuracy for visual navigation.	
5.b.3	Radio navigation.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
6	**Descent and arrival.**	
6.a	Normal descent.	
6.b	Maximum rate descent/non-emergency autorotation (VFR and IFR).	
6.c	Autorotative descent.	
6.c.1	Straight-in.	
6.c.2	With turn.	
6.c.3	IMC.	
6.c.4	To landing.	
6.c.5	Power recovery.	
6.d	Instrument arrival.	
7	**Instrument approaches and landing.** Only those instrument approach and landing tests relevant to the simulated helicopter type or systems should be selected from the following list, where tests should be made with limiting wind velocities and with relevant system failures.	
7.a	Precision approach down to decision height/altitude.	
7.a.1	All engines operating.	
7.a.2	One (or more) engine(s) inoperative.	
7.a.3	Autopilot coupled approach (3, 4 axis).	
7.a.4	Manual approach with FD guidance.	
7.a.5	Manual approach without FD guidance (raw data).	
7.a.6	With HUD/EFVS.	
7.a.7	Approach procedures.	
7.a.7.a	ILS.	
7.a.7.a.1	CAT I published approaches.	
7.a.7.a.2	CAT II published approaches.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
7.a.7.b	DGPS/GLS.	
7.a.7.c	Other.	
7.b	Non-precision approach down to MDA/H.	
7.b.1	All engines operating.	
7.b.2	One (or more) engine(s) inoperative.	
7.b.3	Autopilot coupled approach (3, 4 axis).	
7.b.4	Manual approach with FD guidance.	
7.b.5	Manual approach without FD guidance (raw data).	
7.b.6	With HUD/EFVS.	
7.b.7	Approach procedures.	
7.b.7.a	ARA.	
7.b.7.b	NDB.	
7.b.7.c	VOR, VOR/DME, TACAN.	
7.b.7.d	RNAV/RNP/GNSS/RNP APCH, RNP AR APCH, PINS.	
7.b.7.e	ILS LLZ (LOC), LLZ back course (or LOC-BC).	
7.b.7.f	ILS offset localizer/SDF (Simplified Directional Facility).	
7.b.7.g	Circling (approach prior to visual circling manoeuvre).	
7.c	Missed approach (including at MAPt).	
7.c.1	All engines operating, manual and autopilot coupled.	
7.c.2	One (or more) engine(s) inoperative, manual and autopilot coupled.	
7.c.3	With autopilot/stability augmentation system failure.	
8	**Visual approaches.**	
8.a	Normal.	
8.b	Steep.	

Number	Functions and Subjective Tests	Applicability Yes / No
8.c	Shallow.	
8.d	Vertical.	
8.e	Elevated landing sites/pinnacle/ridgelines/slope.	
8.f	Helideck (ship)/rig.	
8.g	Confined area.	
8.h	Crosswind/tailwind.	
8.i	Visual traffic pattern.	
8.j	Visual circling to land manoeuvre after an instrument approach.	
8.k	Quick stop.	
8.l	Forced landing approach.	
8.m	Transition to hover.	
8.n	With HUD/EFVS.	
8.o	Other.	
8.p	Balked landing.	
8.p.1	All engines operating.	
8.p.2	One engine inoperative.	
8.p.3	Balked rig/deck landing.	
8.q	CAT A or PC1/PC2 operation for all certified profiles from 300 m (1 000 ft) above heliport elevation to or after LDP.	
9	**Landing transition/touchdown.**	
9.a	From a hover.	
9.b	Running.	
9.c	Slope.	
9.d	Surface (hard, soft, water).	

Number	Functions and Subjective Tests	Applicability Yes / No
9.e	Crosswind/tailwind.	
9.f	High altitude.	
9.g	Snow/sand/dust/water spray.	
9.h	Elevated landing sites/pinnacle/ridgelines.	
9.i	Helideck (ship)/rig.	
9.j	From a visual approach.	
9.k	From an instrument approach to minimums and visual final approach thereafter.	
9.l	From autorotation.	
9.m	With anti-torque/directional control malfunction.	
9.n	Other.	
9.o	CAT A operation for all certified profiles (PC1/PC2).	
9.o.1	Landing with engine failure prior to LDP.	
9.o.2	Landing with engine failure at or after LDP.	
10	**Engine shutdown and parking.**	
10.a	Engine and systems operation.	
10.b	Parking brake operation.	
10.c	Rotor disengagement and deceleration.	
10.d	Rotor brake operation.	
10.e	Emergency evacuation.	
10.f	Other.	
11	**Any flight phase.**	
11.a	Helicopter and powerplant systems operation (where fitted) including associated abnormal and emergency procedures.	
11.a.1	Air conditioning and ventilation system.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
11.a.2	Autopilot and flight director.	
11.a.3	Stability and control augmentation system.	
11.a.4	Communications.	
11.a.5	Electrical system.	
11.a.6	Fire and smoke detection and suppression system.	
11.a.7	Flight controls.	
11.a.8	Flight control computers.	
11.a.9	Stabilizer/stabilator.	
11.a.10	Fuel and oil systems.	
11.a.11	Hydraulic system.	
11.a.12	De-icing/anti-icing system.	
11.a.13	Landing gear including landing gear operating time and floats deployment.	
11.a.14	Lighting (internal and external).	
11.a.15	Oxygen system.	
11.a.16	Pneumatic system.	
11.a.17	Auxiliary engine/auxiliary power unit (APU).	
11.a.18	Engine.	
11.a.19	Transmission systems.	
11.a.20	Rotor systems.	
11.a.21	Airborne radar used for weather avoidance, offshore operations and approaches (ARA).	
11.a.22	Terrain awareness warning systems and airborne collision avoidance systems (e.g. HTAWS, EGPWS, GPWS, TCAS).	
11.a.23	Flight data display systems.	
11.a.24	Flight instruments system.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
11.a.25	Flight management systems.	
11.a.26	Head-up displays (including EFVS, if appropriate).	
11.a.27	Navigation systems.	
11.a.28	Wind shear avoidance equipment.	
11.a.29	Electronic flight bag.	
11.a.30	Automatic checklists (normal, abnormal and emergency procedures).	
11.a.31	Voice activated systems.	
11.a.32	Other.	
11.b	Airborne and other miscellaneous procedures.	
11.b.1	Holding.	
11.b.2	Air hazard avoidance (traffic, weather, including visual correlation).	
11.b.3	Mast bumping.	
11.b.4	Inadvertent entry into IMC.	
11.b.5	Recovery from unusual attitudes.	
11.b.6	Wind shear/microburst encounters.	
11.b.7	Airborne weather radar.	
11.b.8	Engine failure – restart.	
11.b.9	High altitude operations.	
11.b.10	Brake and tire failures.	
11.b.11	Other.	
11.c	Master matrix malfunctions (see Part I, Appendix C, paragraph 1.1).	
11.c.1	Stability augmentation malfunction in flight.	
11.c.2	Autopilot malfunction in flight.	
11.c.3	Engine fire on ground or in the hover.	

Number	Functions and Subjective Tests	Applicability Yes / No
11.c.4	Engine fire in forward flight.	
11.c.5	Engine malfunctions.	
11.c.6	Airframe fire and smoke on ground or in the hover.	
11.c.7	Airframe fire and smoke in forward flight.	
11.c.8	Engine failure before CDP/rejected take-off.	
11.c.9	Engine failure after CDP (multi-engine).	
11.c.10	OEI instrument approaches and go-around.	
11.c.11	OEI instrument approaches and landing.	
11.c.12	Autorotation to engine off landing.	
11.c.13	Incipient vortex ring/power settling at altitude.	
11.c.14	Incipient vortex ring/power settling on approach.	
11.c.15	Recovery from unusual attitudes.	
11.c.16	MGB/IGB/TRGB chip detector/oil pressure warning in the hover.	
11.c.17	MGB/IGB/TRGB chip detector/oil pressure warning in forward flight.	
11.c.18	Hydraulic failure in the hover.	
11.c.19	Hydraulic failure in forward flight.	
11.c.20	Hydraulic jack stall (servo transparency).	
11.c.21	Instrumentation/indication failure VFR.	
11.c.22	Instrumentation/indication failure IFR.	
11.c.23	DC system failure.	
11.c.24	AC system failure.	
11.c.25	Battery failure.	
11.c.26	Total electrical failure.	
11.c.27	Fuel transfer failure.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
11.c.28	Fuel supply malfunction.	
11.c.29	Landing gear malfunction.	
11.c.30	Loss of TR effectiveness.	
11.c.31	TR drive failure in the hover.	
11.c.32	TR drive failure in forward flight.	
11.c.33	TR control failure in the hover.	
11.c.34	TR control failure in forward flight.	
11.c.35	Coupled control malfunction.	
11.c.36	Uncoupled control malfunction.	
11.c.37	Dynamic rollover.	
11.c.38	Severe vibration.	
11.c.39	Ground resonance.	
11.c.40	Retreating blade stall.	
11.c.41	Rotor and airframe icing.	
11.c.42	Engine icing.	
11.c.43	Anti-icing system malfunctions.	
11.c.44	Ditching.	
11.c.45	FADEC failures.	
11.c.46	Other.	

Number	Functions and Subjective Tests	Applicability Yes / No
12	**Visual System.** This section is written in the context of the operator presenting models of real-world or fictitious airports and other landing areas, serviced by the helicopter type being simulated, for use in completion of the functions and subjective tests described in this appendix. The real-world models should also be airports and landing areas that are used regularly in the training programme(s). However, where the requirement allows, the operator may elect to use demonstration models for use during the device initial qualification which need not be fully up-to-date nor replicate any particular airport (fictitious airport). Not all elements described in this section need to be found in a single airport/landing area scene. However, all of the elements described in this section should be found throughout a combination of the required airport/landing area model(s) described below. During recurrent evaluations the NAA may select any visual scene used in the operator's training programme(s) for completion of the functions and subjective tests, provided these visual scenes were modelled with the features required.	
12.a	**Functional test content requirements.** The following are the minimum airport/landing area model content requirements to satisfy visual capability tests, and provide suitable visual cues to allow completion of all functions and subjective tests described in this appendix. FSTD operators are encouraged to use the model content described below for the functions and subjective tests. Note.— *The term "landing area" used herein includes both prepared (e.g. airport pad, oil rig, hospital) and unprepared (e.g. confined area, pinnacle, slope) helicopter operations areas.*	
12.a.1	Airport/landing area scenes.	
12.a.1.a	A minimum of four (4) real-world airport/landing area models. Real-world models need to be consistent with published data used for helicopter operations and capable of demonstrating all the visual system features below. Each model should be acceptable to the operator's NAA and should be selectable from the IOS.	
12.a.1.a.1	At least one (1) specific airport.	
12.a.1.a.2	At least one (1) helicopter landing area situated on a substantially elevated surface with respect to the surrounding structures or terrain (e.g. building top, offshore oil rig).	
12.a.1.a.3	At least one (1) helicopter landing area that meets the definition of a confined landing area.	
12.a.1.a.4	At least one (1) helicopter landing area on a sloped surface where the slope is at least 2.5°.	

Number	Functions and Subjective Tests	Applicability Yes / No
12.a.1.b	A minimum of one (1) representative airport model and one (1) helicopter landing area. These models should be acceptable to the operator's NAA and selectable from the IOS. *Note.— Real-world models need to be consistent with published data used for helicopter operations.*	
12.a.1.c	A minimum of one (1) generic airport/heliport model. This model should be acceptable to the operator's NAA and selectable from the IOS. *Note.— Real-world models need to be consistent with published data used for helicopter operations.*	
12.a.2	Visual scene fidelity.	
12.a.2.a	The visual scene should correctly represent the parts of the airport/landing area and its surroundings used in the training programme. Visual cues should enable assessment of the rate of change of height, height AGL, translational displacements and rates during take-off, low altitude/low airspeed manoeuvring, approach, hover and landing.	
12.a.2.b	The fidelity of the visual scene and visual cues should be sufficient for the flight crew to: • visually identify the airport/landing area; • determine the position of the simulated helicopter; • successfully accomplish take-offs, approaches, and landings; and • manoeuvre around the airport/landing area on the ground or in a hover/air taxi as necessary. Visual cues availability should enable the flight crew to assess the rate of change of height and translational displacements and rates, during take-off and landing.	
12.a.2.c	Visual scenes with sufficient scene content for the flight crew to successfully accomplish take-offs, approaches and landings.	
12.a.2.d	For cross-country flights, sufficient scene ground details to allow visual navigation using appropriate scale map, as dictated by the training programme and at typical altitudes over a sector length equal to 30 minutes at an average cruise speed.	
12.a.3	Landing areas, runways and taxiways.	
12.a.3.a	The landing areas, airport runways and taxiways.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
12.a.3.b	Representative landing areas, runways and taxiways.	
12.a.3.c	Generic landing areas, runways and taxiways.	
12.a.4	If appropriate to the airport, two parallel runways and one crossing runway displayed simultaneously; at least two runways should be capable of being lit simultaneously.	
12.a.5	Helicopter landing areas and runway threshold elevations and locations should be modelled to provide correlation with helicopter systems (e.g. HUD, GPS, compass, altimeter).	
12.a.6	Slopes in landing areas, runways, taxiways, and ramp areas should not cause distracting or unrealistic effects, including pilot eyepoint height variation.	
12.a.7	Helicopter landing area surface, markings and lighting.	
12.a.7.a	Landing area surface and markings for each helicopter landing area should include the following, if appropriate:	
12.a.7.a.1	Markings for standard heliport identification (“H” and location), other specific marking such as a hospital pad, aiming point and aiming circle, where appropriate, properly sized, coloured and oriented.	
12.a.7.a.2	TLOF.	
12.a.7.a.3	FATO designation markings as appropriate (including design size, “D” value, weight limitations, etc., where appropriate).	
12.a.7.a.4	Safety areas, OFS and LOS as appropriate.	
12.a.7.a.5	Signs as appropriate for model used.	
12.a.7.a.6	Windsock that gives appropriate wind cues.	
12.a.7.b	Lighting of appropriate colours for the helicopter landing area including the following:	
12.a.7.b.1	Landing direction.	
12.a.7.b.2	Raised and flush FATO, TLOF perimeter and flood lighting.	
12.a.7.b.3	Windsock lighting.	
12.a.7.b.4	Visual approach aids.	
12.a.7.b.5	Approach lighting of appropriate colour.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
12.a.7.c	Taxiway and movement area and markings associated with the helicopter landing area:	
12.a.7.c.1	Taxiways/taxi routes.	
12.a.7.c.2	Aprons.	
12.a.7.d	Taxiway lighting of appropriate colours, directionality, behaviour and spacing, associated with each pad:	
12.a.7.d.1	Taxiways/taxi routes.	
12.a.7.d.2	Aprons.	
12.a.8	Airport surface, markings and lighting:	
12.a.8.a	Runway surface and markings for each “in-use” runway should include the following, if appropriate:	
12.a.8.a.1	Threshold markings.	
12.a.8.a.2	Runway numbers.	
12.a.8.a.3	Touchdown zone markings.	
12.a.8.a.4	Fixed distance markings.	
12.a.8.a.5	Edge markings.	
12.a.8.a.6	Centre line markings.	
12.a.8.a.7	Distance remaining signs.	
12.a.8.a.8	Signs at intersecting runways and taxiways.	
12.a.8.a.9	Windsock that gives appropriate wind cues.	
12.a.8.b	Lighting of appropriate colours for the runway in use including the following:	
12.a.8.b.1	Threshold lights.	
12.a.8.b.2	Edge lights.	
12.a.8.b.3	End lights.	
12.a.8.b.4	Centre line lights.	
12.a.8.b.5	Touchdown zone lights.	

Number	Functions and Subjective Tests	Applicability Yes / No
12.a.8.b.6	Lead-off lights.	
12.a.8.b.7	Appropriate visual landing aid(s) for that runway.	
12.a.8.b.8	Appropriate approach lighting system for that runway.	
12.a.8.b.9	Windsock lighting.	
12.a.8.c	Taxiway surface and markings associated with each “in-use” runway:	
12.a.8.c.1	Edge markings.	
12.a.8.c.2	Centre line markings.	
12.a.8.c.3	Runway holding position markings.	
12.a.8.c.4	ILS critical area markings.	
12.a.8.c.5	All taxiway markings, lighting, and signage to taxi, as a minimum, from a designated parking position to a designated runway and return, after landing on the designated runway, to a designated parking position; a low visibility taxi route (e.g. surface movement guidance control system, follow-me truck, daylight taxi lights) should also be demonstrated for those operations authorized in low visibilities. The designated runway and taxi routing should be consistent with that airport for operations in low visibilities.	
12.a.8.d	Taxiway lighting of appropriate colours, directionality, behaviour and spacing, associated with each “in-use” runway:	
12.a.8.d.1	Edge lights.	
12.a.8.d.2	Centre line lights.	
12.a.8.d.3	Runway holding position and ILS critical area lights.	
12.a.9	Required visual model correlation with other aspects of the airport and landing area environment simulation.	
12.a.9.a	The airport or helicopter landing area model should be properly aligned with the navigational aids that are associated with operations at the runway “in-use” or helicopter landing area.	
12.a.9.b	The simulation of runway or helicopter landing area contaminants should be correlated with the displayed runway surface and lighting.	
12.a.10	Airport and helicopter landing area buildings, structures, objects and lighting.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
12.a.10.a	Buildings, structures and lighting:	
12.a.10.a.1	The airport or helicopter landing area buildings, structures, objects and lighting.	
12.a.10.a.2	Representative airport or helicopter landing area buildings, structures, objects and lighting.	
12.a.10.a.3	Generic airport or helicopter landing area buildings, structures, objects and lighting.	
12.a.10.b	Representative moving and static clutter (e.g. other helicopters and aeroplanes, power carts, tugs, fuel trucks).	
12.a.10.c	Apron markings (e.g. hazard markings, lead-in lines), lighting and a marshaller.	
12.a.11	Terrain and obstacles.	
12.a.11.a	Terrain and obstacles within 46 km (25 NM) of the reference airport or helicopter landing area with appropriate colours and textures for the simulated area. This includes ground objects of sufficient number, appropriate size and perspective.	
12.a.11.b	Representative depiction of terrain and obstacles within 18.5 km (10 NM) of the reference airport or landing area with colours and textures as appropriate.	
12.a.11.c	Depiction of terrain topographical features within 9.25 km (5 NM) of reference airport or landing area. A limited area flat world is acceptable.	
12.a.11.d	General terrain characteristics: below 1 500 m (5 000 ft) visual scene with adequate terrain features to permit navigation by sole reference to visual landmarks according to appropriate charts (typically 1:500 000, 1:250 000, 1:100 000 scale mapping). Terrain contouring should be suitably represented.	
12.a.11.e	Buildings, trees, or other vertical obstructions in the immediate vicinity of the landing area.	
12.a.11.f	Suspended wires in the immediate vicinity of the landing area.	
12.a.12	Significant, identifiable natural and cultural features and moving airborne traffic.	
12.a.12.a	Significant, identifiable natural and cultural features within 46 km (25 NM) of the reference airport or helicopter landing area. *Note.— This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only to provide a reasonable facsimile of runway orientation.*	

Number	Functions and Subjective Tests	Applicability Yes / No
12.a.12.b	Representative depiction of significant and identifiable natural and cultural features within 18.5 km (10 NM) of the reference airport or helicopter landing area. *Note.— This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only to provide a reasonable facsimile of runway orientation.*	
12.a.12.c	Representative moving airborne traffic (including the capability to present air hazards – e.g. airborne traffic on a possible collision course).	
12.b	Visual scene management.	
12.b.1	All landing area and airport runway, approach and taxiway lighting, and cultural feature lighting intensity for any approach should be capable of being set to six (6) different intensities (0 to 5); all visual scene light-points should fade into view appropriately in accordance with the environmental conditions set in the FSTD.	
12.b.2	Airport runway, approach and taxiway lighting, helicopter landing area approach lighting and cultural feature lighting intensity for any approach should be set at an intensity representative of that used in training for the visibility set; all visual scene light-points should fade into view appropriately.	
12.b.3	The directionality of strobe lights, approach lights, runway edge lights, visual landing aids, runway centre line lights, threshold lights, touchdown zone lights on the runway of intended landing and TLOF or FATO lights should be realistically replicated.	
12.c	Visual feature recognition. *Note.— The following are the minimum distances at which landing areas and runway features should be visible. Distances are measured from the runway threshold or helicopter landing area to a helicopter aligned with the runway or helicopter landing area on an extended 3-degree glide slope in suitable simulated meteorological conditions. For circling approaches, all tests below apply both to the runway used for the initial approach and to the runway of intended landing.*	
12.c.1	For helicopter landing areas:	
12.c.1.a	Heliport definition, strobe lights, approach lights, from 4.8 km (3 sm).	
12.c.1.b	Visual approach aids lights (e.g. HAPI) through approach angles up to 12 degrees.	
12.c.1.c	Taxiway definition from 3.2 km (2 sm).	
12.c.1.d	Markings within range of landing lights for night, dawn or dusk scenes.	
12.c.1.e	Markings as required by the surface resolution test on day scenes.	

Number	Functions and Subjective Tests	Applicability Yes / No
12.c.1.f	Landing direction lights and raised FATO lights from 1.6 km (1 sm).	
12.c.1.g	Flush mounted FATO lights, TLOF lights, and the lighted windsock from 800 m (0.5 sm).	
12.c.1.h	Hover taxiway lighting (yellow/blue/yellow cylinders) from TLOF.	
12.c.2	For runways:	
12.c.2.a	Runway definition, strobe lights, approach lights, and runway edge white lights from 8 km (5 sm) of the runway threshold.	
12.c.2.b	Visual approach aids lights (VASIS, PAPI, etc.) from 8 km (5 sm) of the runway threshold.	
12.c.2.c	Visual approach aids lights (VASIS, PAPI, etc.) from 4.8 km (3 sm) of the runway threshold.	
12.c.2.d	Runway centre line lights and taxiway definition from 4.8 km (3 sm).	
12.c.2.e	Threshold lights and touchdown zone lights from 3.2 km (2 sm).	
12.c.2.f	Runway markings within range of landing lights for night, dawn or dusk scenes.	
12.c.2.g	Runway markings as required by the surface resolution test on day scenes.	
12.c.2.h	For circling approaches, the runway of intended landing and associated lighting should fade into view in a non-distracting manner.	
12.d	Selectable airport visual scene capability for:	
12.d.1	Night.	
12.d.2	Dusk or dawn.	
12.d.3	Day.	
12.d.4	Dynamic effects — the capability to present multiple ground and air hazards, such as an aeroplane or another helicopter crossing the active runway or converging airborne traffic, a supply ship in the vicinity of the oil rig when the helicopter is on final approach for landing, etc.; hazards should be selectable via controls at the instructor station.	
12.d.5	Illusions — operational visual scenes which portray representative physical relationships known to cause landing illusions, for example, short runways, landing approaches over water, uphill or downhill runways, rising terrain on the approach path and unique topographic features. *Note.— Illusions may be demonstrated at a generic airport or at a specific airport.*	

Number	Functions and Subjective Tests	Applicability Yes / No
12.e	Correlation with helicopter and associated equipment.	
12.e.1	Visual system compatibility with aerodynamic programming.	
12.e.2	Visual cues to relate to actual helicopter responses.	
12.e.3	Visual cues to enable assessing sink rate and depth perception during landings.	
12.e.4	Accurate portrayal of environment relating to helicopter attitudes.	
12.e.5	The visual scene should correlate with integrated helicopter systems, where fitted (e.g. terrain, traffic and weather avoidance systems and HUD/EFVS).	
12.e.5.a	Weather radar returns should correlate with the visual scene.	
12.e.5.b	Radar equipment used for offshore operations (ARA) should provide appropriate returns simulation correlated with the visual scene.	
12.e.5.c	Terrain awareness warning system (e.g. HTAWS, EGPWS, GPWS) should correlate with the visual scene.	
12.e.5.d	Airborne collision avoidance systems (e.g. TCAS) should correlate with the visual scene.	
12.e.6	The effect of rain removal devices should be provided (i.e. the reduction of rain defocus once activated).	
12.e.7	The visual effects for each visible, ownship, helicopter external light(s) should be provided – taxi, landing and search light lobes including independent operation.	
12.e.8	Dynamic visual representation of rotor blades and tip path including effects of rotor start-up and shutdown as well as orientation of the rotor disc due to pilot control input.	
12.e.9	Visual representation of rotor blade tip path plane and orientation due to pilot control input.	
12.e.10	The visual system should provide appropriate height and 3-D object collision detection feedback, based on helicopter geometry, to support training.	
12.f	Scene quality.	
12.f.1	Quantization.	
12.f.1.a	Surfaces and textural cues should be free from apparent quantization (aliasing).	
12.f.1.b	Surfaces and textural cues should not create distracting quantization (aliasing).	

Number	Functions and Subjective Tests	Applicability
		Yes / No
12.f.2	System capable of portraying full colour realistic textural cues.	
12.f.3	The system light-points should be free from distracting jitter, smearing or streaking.	
12.f.4	System capable of providing focus effects that simulate rain.	
12.f.5	System capable of providing light-point perspective growth.	
12.f.6	Demonstration of occulting through each channel of the system in an operational scene.	
12.g	Environmental effects.	
12.g.1	The displayed scene should correspond to the appropriate surface contaminants and include runway lighting reflections for wet, partially obscured lights for snow, or suitable alternative effects.	
12.g.2	Special weather representations, which include the sound, motion and visual effects of light, medium and heavy precipitation near a thunderstorm on take-off, approach and landings at and below an altitude of 600 m (2 000 ft) above the airport or landing area surface and within a radius of 16 km (10 sm) from the aerodrome.	
12.g.3	One airport or landing area with a snow scene, if appropriate to the operator's area of operations, to include terrain snow and snow-covered surfaces.	
12.g.4	In-cloud effects such as variable cloud density, speed cues and ambient changes should be provided.	
12.g.5	The effect of multiple cloud layers representing few, scattered, broken and overcast conditions giving partial or complete obstruction of the ground scene.	
12.g.6	The effect of a cloud layer with adjustable base and top giving complete obstruction of the ground scene.	
12.g.7	Gradual breakout to ambient visibility/RVR, defined as up to 10% of the respective cloud base or top, 6.1 m (20 ft) ≤ transition layer ≤ 61 m (200 ft); cloud effects should be checked at and below a height of 600 m (2 000 ft) above the aerodrome or helicopter landing area and within a radius of 16 km (10 sm) from the aerodrome or helicopter landing area. Transition effects should be complete when the IOS cloud base or top is reached when exiting and start when entering the cloud, i.e. transition effects should occur within the IOS defined cloud layer.	
12.g.8	Visibility and RVR measured in terms of distance. Visibility/RVR should be checked at and below a height of 600 m (2 000 ft) above the aerodrome or helicopter landing area and within a radius of 16 km (10 sm) from the aerodrome or helicopter landing area.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
12.g.9	Patchy fog (sometimes referred to as patchy RVR) giving the effect of variable RVR. The lowest RVR should be that selected on the IOS, i.e. variability is only > IOS RVR.	
12.g.10	Effects of fog on aerodrome or helicopter landing area lighting such as halos and defocus.	
12.g.11	Effect of ownship lighting in reduced visibility, such as reflected glare, to include landing lights, search lights, strobes and beacons.	
12.g.12	Wind cues to provide the effect of blowing snow or sand across a dry runway or taxiway or landing area surface should be selectable from the instructor station.	
12.g.13	The effect of ownship downwash upon the surface (e.g. grass, dirt, water).	
12.g.14	“Whiteout” or “brownout” recirculation effects of own helicopter’s rotor downwash upon various surfaces such as snow, sand, dirt, water and grass including the effects of reduced visibility beginning at a distance above the ground equal to approximately one half the rotor diameter.	
12.g.15	The effects of swell and wind on a 3-dimensional ocean model should be simulated including wind lanes; sea states of 0 to 6 should be provided. Ships and other moving vessels in the ocean should conform to the sea state.	
12.g.16	The effect of trees movement in confined areas.	
12.g.17	Precipitation effects for rain, hail and snow.	
13	**Motion and vibration effects.** The following specific motion and vibration effects are required to indicate the threshold at which a flight crew member should recognize an event or situation. Where applicable below, the FSTD pitch, side loading and directional control characteristics, as well as the vibrations characteristics, should be representative of the helicopter.	
13.a	Taxiing effects such as lateral, directional and longitudinal cues resulting from steering and braking inputs.	
13.b	Effects of runway rumble, oleo deflections, ground speed, uneven runway, runway centre line lights, runway contamination and taxiway characteristics. Procedure: after the helicopter has been preset to the take-off position and then released, taxi at various speeds with a smooth runway and note the general characteristics of the simulated runway rumble effects. Repeat the manoeuvre with a runway roughness of 50% and with maximum roughness. Note the associated motion vibrations affected by ground speed and runway roughness. Similar tests are conducted on taxiways at various taxi speeds.	

Number	Functions and Subjective Tests	Applicability Yes / No
	The associated motion effects for the above tests should also include an assessment of the effects of rolling over centre line lights, of surface discontinuities of uneven runways, and of various taxiway characteristics. If time permits, different gross weights can also be selected as this may also affect the associated vibrations depending on the helicopter type.	
13.c	Friction drag from skid-type landing gear. Procedure: perform a running take-off or a running landing and note a change (increase or decrease) in fuselage vibrations (as opposed to rotor vibrations) due to the friction of dragging the skid along the surface. This vibration will lessen as the ground speed decreases.	
13.d	Translational lift effect (including transverse flow effect). Procedure: from a stabilized in-ground-effect (IGE) hover, begin a forward acceleration. When passing through the effective translational lift range, the noticeable effect will be a possible nose pitch-up in some helicopters, an increase in the rate of climb, and a temporary increase in vibration level (in some cases this vibration may be pronounced). This effect is experienced again upon deceleration through the appropriate speed range. During deceleration, the pitch and rate of climb will have the reverse effect, but there will be a similar, temporary increase in vibration level.	
13.e	Bumps/buffets associated with landing gear. Procedure: perform a normal take-off paying special attention to the bumps that could be perceptible due to maximum oleo extension after lift-off. When the landing gear is extended or retracted, motion bumps may be felt when the gear locks into position. Operate the landing gear. Check that the motion cues of the buffet experienced represent the actual helicopter.	
13.f	Rotor out-of-track and/or out-of-balance condition including icing conditions. Procedure: select the malfunction or condition from the IOS. Start the engine(s) normally and check for an abnormal vibration for an out-of-track condition and check for an abnormal vibration for an out-of-balance condition. This test does not require becoming airborne. The abnormal vibration for out-of-track and out-of-balance conditions should be recognized in the frequency range of the inverse of the period P of rotation of the main rotor for each condition, i.e. 1/P for vertical vibration caused by an out-of-track condition, and 1/P for lateral vibration caused by an out-of-balance condition.	

Number	Functions and Subjective Tests	Applicability Yes / No
13.g	Failure of dynamic vibration absorber or similar system as appropriate for the helicopter (e.g. droop stop or static stop). Procedure: the test may be accomplished any time the rotor is engaged. Select the appropriate failure at the IOS, note an appropriate increase in vibration and check that the vibration intensity and frequency increase with an increase in RPM and the vibration intensity increases with an increase in collective application.	
13.h	Tail rotor drive malfunction/vibrations. Procedure: with the engine(s) running and the rotor engaged, select the malfunction and note the immediate increase of medium frequency vibration. The tail rotor operates in the medium frequency range, normally estimated by multiplying the tail rotor gear box ratio by the main rotor RPM. The failure can be recognized by an increase in the vibrations in this frequency range. Vibrations may be transmitted via the pedals as well.	
13.i	Representative cues resulting from touchdown. Procedure: conduct several touchdowns with various rates of descent, from a hover and run-on. Check that the motion cues for the touchdown bumps for each descent rate and speed are representative of the actual helicopter.	
13.j	Tire failures. Procedure: simulate tire failures and note effects of yaw, motion, vibration and sound effects. The pilot may notice some yawing with a failure of multiple tires selected on the same side. This should require the use of the pedal to maintain control of the helicopter. Dependent on the helicopter type, a single tire failure may not be noticed by the pilot and may not cause any special motion effect. Sound or vibration may be associated with the actual tire losing pressure.	
13.k	Engine malfunction and engine damage effects. Procedure: the characteristics of an engine malfunction as prescribed in the malfunction definition document for the particular FSTD must describe the special motion effects felt by the pilot. Note the associated engine instruments varying according to the nature of the malfunction and note the replication of the effects of the airframe vibrations. *Note.— Motion effects apply to devices which include a motion system.*	

Number	Functions and Subjective Tests	Applicability Yes / No
13.l	Tail strikes. Procedure: tail-strikes can be checked by over-rotation of the helicopter at a quick stop or during autorotation to the ground. It can also be checked in the hover by a rapid aft cyclic input. The motion effect should be felt initially by a motion bump as the tail guard hits the surface. A nose down pitching moment may possibly be noticeable after the strike.	
13.m	Vortex ring state (settling with power): Procedure: specific procedures may differ between helicopters and may be prescribed by the helicopter manufacturer or other subject matter expert. However, the following information is provided for illustrative purposes. To enter the manoeuvre, reduce power below hover power descending vertically or near vertically, allowing sink rate to increase to 1.5 m/s (300 ft/min) or more (actual sink rate value will depend on the helicopter type simulated). Adjust attitude to obtain airspeeds of less than 10 knots. The aircraft will shudder entering the vortex ring state. During the initial stage (when a large amount of excess power is available), a large application of collective pitch may arrest rapid descent. If done carelessly or too late, collective increase can aggravate the situation resulting in more turbulence and an increased rate of descent and an increase in vibrations level. In single-rotor helicopters, the recovery can be accomplished by applying cyclic to gain airspeed and arrest the upward induced flow of air and/or by lowering the collective (altitude permitting). Normally, gaining airspeed is the preferred method as less altitude is lost. In tandem-rotor helicopters, fore and aft cyclic inputs aggravate the situation. By lowering thrust (altitude permitting) and applying lateral cyclic input or pedal input to arrest the upward induced flow of air, the pilot can accomplish recovery.	
13.n	Retreating blade stall. Procedure: specific procedures may differ between helicopters and may be prescribed by the helicopter manufacturer or other subject matter expert. However, the following information is provided for illustrative purposes: to enter the manoeuvre, increase forward airspeed; the effect will be recognized through the development of a low frequency vibration, pitching up of the nose, and a roll in the direction of the retreating blade. High weight, low rotor RPM, high density altitude, turbulence or steep, abrupt turns are all conducive to retreating blade stall at high forward airspeeds. Correct recovery from retreating blade stall requires the collective to be lowered first, which reduces the disk loading. Aft cyclic can then be used to slow the helicopter.	

Number	Functions and Subjective Tests	Applicability Yes / No
13.o	High speed vibrations.	
13.p	Buffet due to atmospheric disturbances.	
13.q	Other.	
14	**Sound system.** *Note.— Checks should be performed with the motion and vibration systems ON.*	
14.a	Precipitation.	
14.b	Rain removal equipment (e.g. wipers).	
14.c	Significant helicopter noises perceptible to the pilot during normal operations, such as noises from engine, transmissions, rotors or other sources, to a level comparable to that found in the helicopter. Representative sound directionality.	
14.d	Significant helicopter cockpit sounds and those which result from an action by the pilot.	
14.e	Abnormal operations for which there are associated sound cues including, but not limited to, engine, rotors, transmissions malfunctions, landing gear/tire malfunctions and tail guard/stinger/hockey stick strike.	
14.f	Sound of a crash when the helicopter is landed in excess of limitations or in unusual attitudes.	
15	**Special effects.**	
15.a	Effects of airframe, engine and rotor icing. Procedure: with the FSTD airborne, in a clean configuration, nominal altitude and cruise airspeed, autopilot ON, engine and airfoil anti-ice/de-ice systems deactivated, activate icing conditions at a rate that allows monitoring of FSTD and systems response. Icing recognition will include an increase in gross weight, increase in power required to maintain level flight, airspeed decay, change in FSTD pitch attitude, change in engine performance indications (other than due to airspeed changes), and change in data from pitot/static system, or symptoms of rotor out-of-track or out-of-balance. Activate heating, anti-ice, or de-ice systems independently. Recognition will include proper effects of these systems, eventually returning the simulated helicopter to normal flight.	
15.b	Airflow patterns and respective effects associated with large structures, such as buildings and oil rigs, confined areas, mountain peaks including demarcation lines, etc.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
15.c	Special atmospheric effects, as may be required for a specific training programme, such as arctic sea smoke, katabatic winds, mountain effects (rotors, demarcation lines, etc.), oil rig exhaust turbulence, wake vortices and downwash effects from other aircraft, etc.	
16	**Air traffic control (ATC) system.** *Note.− All functions below can be performed directly by the instructor or be programmed from the IOS using features of an ATC environment simulation system.*	
16.a	Automated weather reporting.	
16.b	Party-line (background chatter).	
16.c	Phraseology.	
16.d	Flight phase specific ATC frequency recognition.	
16.e	Instructor override of the system.	
16.f	Other.	
17	**Instructor Operating Station.**	
17.a	Repositions. *Note.— Repositions should end in-trim at the appropriate speed and configuration for the point.*	
17.a.1	Parking spot.	
17.a.2	Take-off position.	
17.a.3	Approach position (at least at three distances of 1.8, 5.5, 9.3 km (1, 3, 5 nm) from the runway threshold or helicopter landing area).	
17.a.4	Elevated surface position (building top, offshore oil rig, etc.).	
17.a.5	Confined landing area.	
17.a.6	On a slope.	
17.a.7	Other.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
17.b	Resets.	
17.b.1	System.	
17.b.2	Temperature.	
17.b.3	Fluids and agents.	
17.c	Environment.	
17.c.1	Weather presets.	
17.c.1.a	CAVU (ceiling and visibility unlimited)	
17.c.1.b	CAVOK (ceiling and visibility Ok).	
17.c.1.c	VFR.	
17.c.1.d	Non-precision approach minimums.	
17.c.1.e	Precision approach minimums (CAT I, CAT II, EFVS minimums, as appropriate).	
17.c.2	Visual effects.	
17.c.2.a	Time of day (day, dusk or dawn, night).	
17.c.2.b	Clouds (bases, tops, layers, types, density).	
17.c.2.c	Visibility in kilometres/statute miles.	
17.c.2.d	RVR in metres/feet.	
17.c.2.e	Special effects (precipitation; thunderstorms; blowing snow; blowing sand; etc.).	
17.c.2.f	Sand/dust/snow/water downwash/recirculation effect ON/OFF.	
17.c.2.g	Sea state conditions (0-6).	
17.d	Wind speed and direction.	
17.d.1	Surface.	
17.d.2	Intermediate levels.	
17.d.3	Typical gradient.	
17.d.4	Gusts with associated heading and speed variance.	

Number	Functions and Subjective Tests	Applicability
		Yes / No
17.d.5	Turbulence.	
17.e	Temperature — surface.	
17.f	Atmospheric pressure (QNH, QFE).	
17.g	Airport/heliport.	
17.g.1	To include active runway or landing area selection.	
17.g.2	Airport/heliport lighting controls.	
17.g.3	Airport/heliport preset positions (take-off, approach, oil rig, etc.).	
17.g.4	Landing surface conditions (rough, smooth, icy, wet, etc.).	
17.g.5	Dynamic effects including ground and airborne traffic.	
17.h	Helicopter configuration (fuel, weight, CG, etc., in imperial and metric units).	
17.h.1	Gross weight.	
17.h.2	Fuel loading.	
17.h.3	Payload.	
17.h.4	CG (in units appropriate to the helicopter type, e.g. inches, mm).	
17.h.5	Helicopter systems status/control (e.g. rapid navigation system (NAV) alignment (IRS, GPS, AHRS), others).	
17.h.6	Ground crew functions (ground power, etc.).	
17.i	FMS − reloading of programmed data unless precluded by installed equipment.	
17.j	Plotting and recording (take-off and approach).	
17.k	Helicopter malfunctions (inserting and removing).	
17.l	Sound controls (ON, OFF and adjustment; indication of when the sound level is set to a value other than the approved level).	
17.m	Motion system (ON, OFF and emergency stop).	
17.n	Control loading system (ON, OFF and emergency stop).	

Number	Functions and Subjective Tests	Applicability Yes / No
17.o	Vibration system (ON, OFF and emergency stop).	
17.p	Simulator master/emergency power switch “OFF”.	
17.q	Observer seats position/adjustment system and positive restraint system (for FSTD with motion).	
17.r	Communication between the instructor/observer(s) and the flight crew.	
17.s	Freezes/resets.	
17.s.1	Complete simulation freeze.	
17.s.2	Flight/problem freeze.	
17.s.3	Position freeze.	
17.s.4	Fuel freeze.	
17.s.5	Ground speed control.	
17.s.6	Standard atmosphere reset.	

Appendix D

Future Doc 9625 (MCQFSTD) updates

Refer to Volume II, Part II, Appendix D.

Attachments A to R

GUIDANCE MATERIAL

Refer to Volume II, Part II, Attachments A to R for relevant guidance material.

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