Manual of Criteria for the Qualification of Flight Simulation Training Devices

Volume I — Aeroplanes

Approved by the Secretary General and published under his authority

Third Edition — 2009

International Civil Aviation Organization
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AMENDMENTS

Amendments are announced in the supplements to the Catalogue of ICAO Publications; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such 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 this manual are the result of the experience and expertise provided by National Aviation Authorities (NAA) and aeroplane and FSTD operators and manufacturers.

First Edition

From 1989 to 1992 a specially convened international working group held several meetings with the stated purpose of establishing common test criteria that would be recognized internationally. The criteria that resulted from the activities of this working group were presented to a Conference held in London, United Kingdom, in January 1992. These criteria were contained in the appendices to the first edition of this manual. Appendix A described the minimum requirements for qualifying aeroplane flight simulators of two levels (Levels I and II). The validation and functional tests associated with the particular level of flight simulator were contained in Appendices B and C.

Second Edition

During 2001, a working group under the joint chairmanship of the US Federal Aviation Administration (FAA) and the European Joint Aviation Authorities (JAA) held two meetings to review and modernize the standards contained within this manual. The second edition of this manual updated the minimum standards for aeroplane flight simulator qualification. This reflected the changes in both simulation technology and the understanding of the process of flight simulator qualification in the previous ten years. As a result of technology changes and operational tasks, this manual only defined the highest level of flight simulator. Changes were made to the standards and testing requirements in each Appendix. These changes were introduced with great care being exercised to avoid increasing the burden of testing unnecessarily. As before, Appendix A described the minimum requirements for qualifying flight simulators. The validation and functions tests were contained in Appendices B and C. Finally, Attachments A through H were added as information and explanatory material to provide advice and guidance for all interested parties.

Third Edition

The technical standards defined within the second edition now form the basis for the highest level of aeroplane flight simulator in both 14 CFR FAR Part 60 “Flight Simulation Training Device Initial and Continuing Qualification and Use” and JAR–FSTD A “Aeroplane Flight Simulation Training Devices”. The FAA, the JAA and other National Aviation Authorities have developed their own standards for the complete range of Flight Simulation Training Devices (FSTDs) for both aeroplane and helicopter FSTDs. Most recently, ICAO’s Flight Crew Licensing and Training Panel has additionally identified the need for four levels of aeroplane FSTDs to support the Multi-crew Pilot Licence (MPL).

At the Flight Simulation conference of the Royal Aeronautical Society (RAeS) held in London in November 2005, the FAA requested that the RAeS consider leading an international working group to review the technical criteria contained within the second edition of this manual and to expand these criteria to include all flight simulation training devices for both aeroplanes and helicopters.

In response, the RAeS Flight Simulation Group established in March 2006 an International Working Group (IWG) 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, will form the basis for all national and international standards for a complete range of Flight Simulation Training Devices.

The 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.
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 (under preparation)**

- 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 Part II and Part III and are only presented in Part II.

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

The process outcome defines 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 seven standard examples of FSTDs. These FSTD examples are summarized in Part I, Appendix B, and are referred to as “Device Types” 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 FSTD qualification
- Tailoring of existing FSTDs to meet existing or future training needs
- Design of new FSTDs to meet existing or future training needs.

In summary:

**Pilot Licensing, Qualification, Rating or Training Type**

The 15 training types considered are from various NAA definitions. Reference Volume I, Part I, Chapter 4.

**Training Tasks**

The training tasks (approximately 200) were derived from Doc 9868, *Procedures for Air Navigation Services — Training (PANS–TRG)*, as well as material from FAA 14 CFR Part 60 and other NAA documentation.

**Simulation Features**

Twelve simulation features were defined using the FSTD standards tables contained in JAR FSTD A and FAA Part 60 to act as building blocks to describe any level of FSTD.

Other relevant FSTD features such as Instructor Operating Station, Diagnostics, Updates, etc., are covered under a separate simulation feature “Miscellaneous” and apply to all FSTDs.
Fidelity levels

Four fidelity levels of simulation feature were identified:

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

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

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**Figure 1. Training analysis process**
MANUAL OF CRITERIA FOR THE QUALIFICATION OF FLIGHT SIMULATION TRAINING DEVICES

Volume I

Aeroplanes

Part I

Training Task Derived Flight Simulation Requirements
Chapter 1

GLOSSARY OF TERMS AND ABBREVIATIONS

1.1 GLOSSARY OF TERMS

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

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

*Note.— An example is the data used to generate Aeroplane Flight Manual (AFM) or Flight Planning and Cruise Control Manual (FPCCM) values.*

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

*Note.— For additional guidance, see the guidance material in the Attachments to Part II of this document and related reading material listed in Chapter 9 of this Part.*

**Approved training organization (ATO).** A flight crew training organization formally recognized by a National Aviation Authority to deliver training.

**Approved use.** The ability to complete the training, testing or checking tasks as prescribed in this document.

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

**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 their use may be dependent on the outcome of the event, e.g. a step towards a licence issuance, a recurrent evaluation of competency.*

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

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

**Flight simulation training device (FSTD).** A synthetic training device that is in compliance with the minimum requirements for FSTD qualification as described in this manual.

**Flight test data.** Actual aeroplane data obtained by the aeroplane manufacturer (or other approved supplier of data) during an aeroplane flight test programme.
**FSTD approval.** Declaration of the extent to which an FSTD of a specified qualification level may be used by an operator or training organization as agreed by the NAA. It takes account of differences between aeroplanes 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 12 categories that have been used in Part I of this document for the definition of the general and technical requirements for FSTDs.

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

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

**Integrated testing.** Testing of the FSTD such that all aeroplane system models are active and contribute appropriately to the results. None of the aeroplane system models should be substituted with models or other algorithms intended for testing purposes only. This 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.

**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 approved data.

**None (N).** Feature is not required.

**Not applicable (N/A).** That task was not considered as being applicable to that part of the licence type or rating.

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

**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 manual.

**Representative (R).** The intermediate level of required fidelity for a given FSTD feature.

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

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

**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.

**Train.** 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. 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.

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

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

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

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

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

1.2 ABBREVIATIONS

The abbreviations used in this Part I have the following meaning:

A/C: Aircraft
AFM: Aeroplane Flight Manual
ATA: Air Transport Association
ATC: Air Traffic Control
ATO: Approved Training Organization
ATPL: Airline Transport Pilot Licence
CAP: Civil Aviation Publication
CFIT: Controlled Flight Into Terrain
CFR: Code of Federal Regulations
CPL: Commercial Pilot Licence
CQ: Continuing Qualification
CR: Class Rating
DME: Distance Measuring Equipment
EASA: European Aviation Safety Agency
EFIS: Electronic Flight Instrument System
EFVS: Enhanced Flight Vision System
EGPWS: Enhanced Ground Proximity Warning System
eQTG: Electronic Qualification Test Guide
ETOPS: Extended Operations

Note.— ETOPS, recently redefined as extended operations that involve extended diversion time operations, refers in this manual specifically to extended diversion time operations by aeroplanes with two turbine engines.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>RO</td>
<td>Recurrent Operator Training and Checking</td>
</tr>
<tr>
<td>RVR</td>
<td>Runway Visual Range (m or ft)</td>
</tr>
<tr>
<td>S</td>
<td>Specific (as related to fidelity level)</td>
</tr>
<tr>
<td>SARPS</td>
<td>Standards and Recommended Practices</td>
</tr>
<tr>
<td>SOC</td>
<td>Statement of Compliance</td>
</tr>
<tr>
<td>T</td>
<td>Train(ing)</td>
</tr>
<tr>
<td>TAWS</td>
<td>Terrain Awareness Warning System</td>
</tr>
<tr>
<td>TCAS</td>
<td>Traffic alert and Collision Avoidance System</td>
</tr>
<tr>
<td>TGL</td>
<td>Temporary Guidance Leaflet</td>
</tr>
<tr>
<td>TP</td>
<td>Train(ing)-to-Proficiency</td>
</tr>
<tr>
<td>TR</td>
<td>Type Rating Training and Checking</td>
</tr>
<tr>
<td>TRG</td>
<td>Training</td>
</tr>
<tr>
<td>VHF</td>
<td>Very High Frequency</td>
</tr>
<tr>
<td>VOR</td>
<td>VHF Omnidirectional Radio Range</td>
</tr>
<tr>
<td>vs</td>
<td>versus</td>
</tr>
</tbody>
</table>
Chapter 2

VOLUME I CONTENT

2.1 Volume I 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 Chapter 4);

• A summary of seven standard FSTD examples (see Appendix B); and

• A reference to the training task matrix which compares each task, differentiated on the basis of license 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”.

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 seven 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 VII), 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).
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 seven 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-VII\(\Delta\) (Delta), e.g. type IV\(\Delta\).
Chapter 4

LICENCE OR TYPE OF TRAINING

4.1 The 15 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:

4.1.1 From ICAO Annex 1 — Personnel Licensing and PANS-TRG (Doc 9868):

4.1.1.1 MPL1 — Multi-crew Pilot Licence — Phase 1, Core flying skills;
4.1.1.2 MPL2 — Multi-crew Pilot Licence — Phase 2, Basic;
4.1.1.3 MPL3 — Multi-crew Pilot Licence — Phase 3, Intermediate; and
4.1.1.4 MPL4 — Multi-crew Pilot Licence — Phase 4, Advanced.

4.1.2 Traditional Licence and Rating Types or Training Types from FAA and JAA Regulations:

4.1.2.1 IR — Initial Instrument Rating;
4.1.2.2 PPL — Private Pilot Licence;
4.1.2.3 CPL — Commercial Pilot Licence;
4.1.2.4 TR — Type Rating Training and Checking;
4.1.2.5 CR — Class Rating;
4.1.2.6 RL — Recurrent Licence (Proficiency) Training and Checking;
4.1.2.7 RO — Recurrent Operator (Proficiency) Training and Checking;
4.1.2.8 Re — Recency (Take-off and Landing);
4.1.2.9 CQ — Continuing Qualification;
4.1.2.10 IO — Initial Operator Training and Checking; and
4.1.2.11 ATPL — Airline Transport Pilot Licence or Certificate.
5.1 The following definitions extracted from the Procedures for Air Navigation Services — Training (PANS-TRG) 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 nine competency units that are required to be demonstrated are as follows:

5.1.4.1 Apply threat and error management principles.
5.1.4.2 Perform aeroplane ground and pre-flight operations.
5.1.4.3 Perform take-off.
5.1.4.4 Perform climb.
5.1.4.5 Perform cruise.
5.1.4.6 Perform descent.
5.1.4.7 Perform approach.
5.1.4.8 Perform landing.
5.1.4.9 Perform after-landing and post-flight operations.

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 and were assembled from the following documents:

5.2.1 Procedures for Air Navigation Services — Training (PANS-TRG) (Doc 9868); and

5.2.2 FAA Part 60 material.

5.3 The following are examples from PANS-TRG of the training tasks down to the competency element level:

“... 3. Perform Take-off

3.1 Perform pre-take-off and pre-departure preparation
3.2 Perform take-off roll
3.3 Perform transition to instrument flight rules
3.4 Perform initial climb to flap retraction altitude
3.5 Perform rejected take-off
3.6 Perform navigation
3.7 Manage abnormal and emergency situations

4. Perform Climb
   4.1 Perform standard instrument departure/en-route navigation
   4.2 Complete climb procedures and checklists
   4.3 Modify climb speeds, rate of climb and cruise altitude
   4.4 Perform systems operations and procedures
   4.5 Manage abnormal and emergency situations
   4.6 Communicate with cabin crew, passengers and company ...
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 some key components that would lead towards the construction of the FSTD Specification. Consequently, twelve FSTD features were defined from a training perspective that, 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 pilot, instructor and observer seating.

6.1.2 Flight model (aero and engine). Defines the mathematical models and associated data to be used to describe the aerodynamic and propulsion 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.

6.1.4 Aircraft systems. Defines the types of aircraft 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, propulsion, runway rumble and weather effects, and those internal to the cockpit.

6.1.7 Visual cue. Defines the type of out-of-cockpit window image display (e.g. collimated or non-collimated) and 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. HUD and EFVS options are also addressed.

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

6.1.9 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. The focus of this feature is on the terminal area manoeuvring, not on the in-flight cruise phase of flight.

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 and weather conditions, from temperature and pressure to full thunderstorm modelling, etc.
6.1.12 Environment — Aerodromes and terrain. Defines the complexity and level of detail of the simulated aerodrome and terrain modelling required. This includes such items as generic versus customized aerodromes, visual scene requirements, terrain elevation and EGPWS databases.

6.1.13 Miscellaneous. Defines criteria for the following FSTD miscellaneous feature technical requirements:

- instructor station;
- self-diagnostic testing;
- computer capacity;
- automatic testing;
- updates to hardware and software;
- daily pre-flight; and
- 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 level of fidelity 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);
    7.1.1.3 Ground handling;
    7.1.1.4 Aircraft 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 cue; and
    7.1.2.3 Motion cue.

7.1.3 Environment simulation comprising the following simulation features:
    7.1.3.1 Environment — ATC;
    7.1.3.2 Environment — Navigation;
    7.1.3.3 Environment — Weather; and
    7.1.3.4 Environment — Aerodromes and terrain.

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

<table>
<thead>
<tr>
<th>Level</th>
<th>Aircraft simulation</th>
<th>Cueing simulation</th>
<th>Environment simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Not required.</td>
<td>Not required.</td>
<td>Not required.</td>
</tr>
<tr>
<td>Generic</td>
<td>Not specific to aeroplane model, type or variant.</td>
<td>Generic to an aeroplane of its class. Simple modelling of key basic cueing features.</td>
<td>Simple modelling of key basic environment features.</td>
</tr>
<tr>
<td></td>
<td>For visual cueing only: Generic visual environment with perspective sufficient to support basic instrument flying and transition to visual from straight in instrument approaches.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Representative</td>
<td>Representative of an aeroplane of its class, e.g., four engine turbo-fan aeroplane. It does not have to be type specific.</td>
<td>For sound and motion cueing only: Replicates the specific aeroplane to the maximum extent possible. However physical limitations currently only provide representative, not specific, cues.</td>
<td>Representative of the real world environment.</td>
</tr>
<tr>
<td></td>
<td>For visual cueing only: Representative of the real world visual environment and perspective.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific</td>
<td>Replicates the specific aeroplane.</td>
<td>Applicable to visual cueing only: replicates the real world visual environment and (infinity) perspective.</td>
<td>Replicates the real world environment as far as possible for any specific location.</td>
</tr>
</tbody>
</table>
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). Utilizing this approach, the training master matrix described in Appendix C of 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 utilizing the relevant TP device type.

8.2 Definitions of the terms train (T) and train-to-proficiency (TP) are in 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:

ICAO
Annex 1 — Personnel Licensing, Amendment 167; and

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

JAA
JAR-FSTD A, Aeroplane Flight Simulation Training Devices;
JAR-FSTD H, Helicopter Flight Simulation Training Devices;
JAR-STD 1H, 2H, 3H: Helicopter Flight Simulators, Flight Training Devices, Flight and Navigational Procedure Trainers; and
FCL TGL #7, Multi-crew Pilot Licence Training — Air Traffic Control Environment Simulation.

United Kingdom

United States
14 CFR FAR Part 60, Requirements for the Evaluation, Qualification and Maintenance of Flight Simulation Training Devices;
Advisory Circular 120-40B, Aeroplane Simulator Qualification;
Advisory Circular 120-40B, (International) Aeroplane Simulator Qualification;
Advisory Circular 120-45A, Aeroplane Flight Training Device Qualification;
Advisory Circular 120-63, Helicopter Simulator Qualification; and
9.3 Additional related documents are:

International Air Transport Association (IATA):
   *Flight Simulator Design and Performance Data Requirements*, 6th edition, 2000; and

Royal Aeronautical Society publications:

9.4 It is important to regularly monitor regulatory guidance material on the NAA web sites 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, FSTD 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 an aeroplane for PPL, CPL, CR, IR and MPL1;

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

c) for MPL phases 1 to 4, only the ICAO designated PANS–TRG training tasks were considered; and

d) for all other licensing, qualification, rating or training types, the FAA Airline Transport Pilot and Type Rating Practical Test Standards (Chapter 9, 9.2 refers) designated tasks have been considered in addition to the ICAO MPL tasks.
### 2. TRAINING TASK VS TRAINING / LICENCE TYPE MATRIX

<table>
<thead>
<tr>
<th>Ref</th>
<th>UNIT / Element</th>
<th>MPL1</th>
<th>MPL2</th>
<th>MPL3</th>
<th>MPL4</th>
<th>IR</th>
<th>PPL</th>
<th>CPL</th>
<th>TR</th>
<th>ATPL</th>
<th>CR</th>
<th>RL</th>
<th>RO</th>
<th>RE</th>
<th>CQ</th>
<th>IO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ICAO</strong></td>
<td><strong>2. Perform Aircraft Ground and Pre-Flight Operations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICAO 2.1</td>
<td>Perform dispatch duties</td>
<td>N/A</td>
<td>T,TP</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>TP</td>
<td>T,TP</td>
</tr>
<tr>
<td>ICAO 2.2</td>
<td>Provide flight crew and cabin crew briefings</td>
<td>N/A</td>
<td>T,TP</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>TP</td>
<td>T,TP</td>
</tr>
<tr>
<td>ICAO 2.3</td>
<td>Perform pre-flight checks and cockpit preparation</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>T,TP</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>TP</td>
<td>T,TP</td>
</tr>
<tr>
<td>ICAO 2.4</td>
<td>Perform engine start</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>T</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>TP</td>
<td>T,TP</td>
</tr>
<tr>
<td>ICAO 2.5</td>
<td>Perform taxi out</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>T</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>TP</td>
<td>T,TP</td>
</tr>
<tr>
<td>ICAO 2.6</td>
<td>Manage abnormal and emergency situations</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>T</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>T</td>
<td>T,TP</td>
<td>T,TP</td>
<td>N/A</td>
<td>TP</td>
<td>T,TP</td>
</tr>
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Appendix B

FSTD SUMMARY MATRIX

1. SUMMARY MATRIX

For those operators that use the seven FSTD standard examples the summary matrix of Table B-1 applies.

Note.— The content of the summary matrix is considered to have precedence over the contents of the master matrix.

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

2.1 T — See definition in Chapter 1 of this Part for Train.

2.2 TP — See definition in Chapter 1 of this Part for Train-to-Proficiency.

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

2.4 For definition of the derivative simulator feature fidelity levels R1, G(S) and R(S) refer to the Master Matrix defined in Appendix C of this Part.

2.5 For CR the summary matrix specifies fidelity level S for simulation feature Environment — Navigation despite the fact that there are no specific navigation tasks required. This has been done due to the likelihood that all FSTDs these days have a full navigation database capability.

2.6 For Environment — ATC the fidelity level S in the summary matrix above is shown greyed out as this level of fidelity is currently under development. 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 of Part II.)

2.7 The MPL concept is a performance-outcome approach to training. The MPL competency framework should accommodate varying degrees of integration of FSTDs and should support the development of a training programme in which appropriate aircraft and FSTDs are used to ensure optimal transfer of learning; trainees move seamlessly through different components of the learning environment to the work environment.

2.8 Devices for MPL Phase 3

MPL Phase 3 learning outcomes are not specific to type. The Type VI FSTD example indicated in the summary matrix for MPL Phase 3 offers a means, but not the only means, by which the FSTD specifications support the training outcomes. The task analysis indicates the possibility to meet competency outcomes by a combination of training in the Type V and Type VII FSTD examples. The summary of the Type VI device example is deliberately "greyed out" to reflect the fact that the training community is at the time of publication uncertain about the optimal training device for this phase. The ICAO Annex 1 — Personnel Licensing guidance material and the JAR (EASA)-FCL rules also differ in this field and thus the entire issue is subject to the ICAO "proof of concept" mechanism which collects global MPL experiences as a basis for an update of the MPL Phase 3 device definition in 2011.

2.9 Devices for MPL Phase 4

MPL Phase 4 includes, but may not be limited to, an aeroplane type rating. An appropriate combination of device specifications to meet learning outcomes is indicated in the master matrix. The summary matrix however, requires training exclusively in a Type VII device, in compliance with Annex 1, Appendix 3, paragraph 4.

2.10 Guidance during MPL licence implementation and MPL training programmes introduction:

It is suggested that, whilst the MPL training programmes are being introduced and validated, the highest appropriate level devices are used to facilitate the safe and efficient implementation of the MPL requirements.
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 15 “pilot licensing, qualification, rating or training types” described in Chapter 4 of this Part.

1.2 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).

1.3 This is the basic reference material used to define the seven FSTD standard examples and the material contained in Volume I, Part I.

1.4 The FSTD standard examples 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.

1.5 The following paragraphs (2 to 16) contain the printouts of the Master Matrix data for each individual training type of the 15 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 competency element.
### MPL1 — MASTER MATRIX DATA — TRAINING (T) —
THE INTRODUCTION OF A SPECIFIC TRAINING TASK

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## Part I. Training Task Derived Flight Simulation Requirements

### Appendix C. FSTD master matrix

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### 3. MPL2 — MASTER MATRIX DATA

#### 3.1 MPL2 — Master matrix data — Training (T) — The introduction of a specific training task

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4. MPL3 — MASTER MATRIX DATA

4.1 MPL3 — Master matrix data — Training (T) — The introduction of a specific training task

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<th>Ground Handling</th>
<th>A/C Systems</th>
<th>Flight controls and forces</th>
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<th>Visual Cue</th>
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## 4.2 MPL3 — Master matrix data — Training-to-Proficiency (TP)

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### 5. MPL4 — MASTER MATRIX DATA

#### 5.1 MPL4 — Master matrix data — Training (T) — The introduction of a specific training task

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## 5.2 MPL4 — Master matrix data — Training-to-Proficiency (TP)

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6. IR — MASTER MATRIX DATA — TRAINING (T) — THE INTRODUCTION OF A SPECIFIC TRAINING TASK

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

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<td>Modify climb speeds, rate of climb and cruise altitude</td>
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<td>Monitor navigation accuracy</td>
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<td>Monitor and perform en route and descent navigation</td>
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<td>ICAO 9.1</td>
<td>Perform taxi in and parking</td>
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<td>Perform aircraft post-flight operations</td>
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<td>Navigation system setup</td>
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<td>Engine start — Normal</td>
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<td>Taxi</td>
<td>R R R R R G R N N S G G</td>
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<td>Pre-take-off procedures</td>
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<td>After landing</td>
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<td>Parking and securing</td>
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<td>Normal and crosswind — all engines operating</td>
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<td>With engine failure — between V, and 500 ft. above field elevation</td>
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<td>Short-field take-off and maximum performance climb</td>
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<td>Soft-field take-off and climb</td>
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<td>Steep turns</td>
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<td>Steep spiral</td>
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<td>Turns about a point</td>
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<td>‘S-Turns’ across a road or section line</td>
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<td>Climb</td>
<td>R R N R R G G N N N G G</td>
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<td>En-route navigation</td>
<td>R R N R R G R N N S G S*</td>
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<td>Descent</td>
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<td>Aircraft control by reference to instruments</td>
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<td>Stalls — Recovery from: Power-off stalls.</td>
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<td>Recognition/recovery from, approach to stall: Clean configuration</td>
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<td>Recognition/recovery from, approach to stall: Take-off and manoeuvring configuration</td>
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<td>Slow flight</td>
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<td>Spin awareness</td>
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<td>All engines operating (normal)</td>
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<td>Crosswind</td>
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<td>Landing Transition: From a visual approach</td>
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## 8. CPL — MASTER MATRIX DATA — TRAINING (T) — THE INTRODUCTION OF A SPECIFIC TRAINING TASK

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<th>Flight controls and forces</th>
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<th>Visual Cue</th>
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9. **TR — MASTER MATRIX DATA**

9.1 **TR — Master matrix data — Training (T) — The introduction of a specific training task**

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<th>Flight controls and forces</th>
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<th>Visual Cue</th>
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<th>Environment — Navigation</th>
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<td>Perform aircraft post-flight operations</td>
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<td>Perform systems operations and procedures</td>
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<td>Communicate with cabin crew, passengers and company</td>
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<td>8.9 Mach tuck and Mach buffet</td>
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<td>One engine inoperative — manually flown</td>
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### Appendix C. FSTD master matrix I-App C-35

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# 10. CR — Master Matrix Data — Training (T) — The Introduction of a Specific Training Task

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### 11. RL — MASTER MATRIX DATA

#### 11.1 RL — Master matrix data — Training (T) — The introduction of a specific training task

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## Part I. Training Task Derived Flight Simulation Requirements

### Appendix C. FSTD master matrix

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<th>Ground Handling</th>
<th>A/C Systems</th>
<th>Flight controls and forces</th>
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<td>Traffic avoidance (TCAS)</td>
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<td>Terrain avoidance (EGPWS or TAWS)</td>
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<td>All engines operating — autopilot coupled</td>
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<td>One engine inoperative — manually flown</td>
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<td>All engines operating (normal)</td>
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<td>Two engines inoperative (3 or 4 engine aeroplane)</td>
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<td>FAA 11.1</td>
<td>All engines operating</td>
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<td>FAA 11.2</td>
<td>One engine inoperative</td>
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<td>From a circling approach when authorized</td>
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<td>Descending break-out from PRM approach</td>
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<td>FAA 12.1</td>
<td>All engines operating</td>
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<td>With engine failure: One engine inoperative</td>
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<td>Landing Transition: From a circling approach</td>
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<td>Rejected landing</td>
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<td>Zero or partial flaps</td>
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<td>FAA 12.7</td>
<td>Auto-land</td>
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<td>Head-up display (HUD)</td>
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<td>Systems (ATA Code):</td>
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11.2 **RL — Master matrix data — Training-to-Proficiency (TP)**

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### Appendix C. FSTD master matrix

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12. **RO — MASTER MATRIX DATA**

12.1 **RO — Master matrix data — Training (T) — The introduction of a specific training task**

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<td>Modify climb speeds, rate of climb and cruise altitude</td>
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### Appendix C. FSTD Master Matrix

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<td>Replanning and update of approach briefing</td>
<td>S S N S S R N N G S R N</td>
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<td>Perform approach in general</td>
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<td>Perform non precision approach</td>
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<td>Perform approach with visual reference to ground</td>
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<td>Monitor the flight progress</td>
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<td>Manage abnormal and emergency situations</td>
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<td>ICAO  7.8</td>
<td>Perform go-around/missed approach</td>
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<td>Manage abnormal and emergency situations</td>
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<td>ICAO  9.1</td>
<td>Perform taxi in and parking</td>
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<td>Engine start — Non-normal</td>
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<td>Parking and securing</td>
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<td>FAA    4.1</td>
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<td>Instrument with lowest authorized RVR</td>
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<td>One Engine inoperative, en-route</td>
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<td>Turns with and without spoilers</td>
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<td>11.2 One engine inoperative</td>
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<td>S S S S S R R N G S R R</td>
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<td>12.2 Crosswind</td>
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<td>12.3.1 With engine failure: One engine inoperative</td>
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<td>FAA</td>
<td>12.3.2 With engine failure: Two engines inoperative (3 or 4 engine aircraft)</td>
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<td>12.7 Auto-land</td>
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<td>12.8 Enhanced flight vision system (EFVS)</td>
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<td>12.9 Head-up display (HUD)</td>
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<td>13.2.3 Autopilot (22)</td>
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13. **RE — MASTER MATRIX DATA — TRAINING (T) — THE INTRODUCTION OF A SPECIFIC TRAINING TASK**

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### 14. CQ — MASTER MATRIX DATA — TRAINING-TO-PROFICIENCY (TP)

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### Part I. Training Task Derived Flight Simulation Requirements

#### Appendix C. FSTD master matrix

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<th>Source</th>
<th>Competency Element or Training Task</th>
<th>Cockpit Layout and Structure</th>
<th>Flight model (Aero and engine)</th>
<th>Flight controls and forces</th>
<th>Sound Cue</th>
<th>Visual Cue</th>
<th>Motion Cue</th>
<th>Environment — ATC</th>
<th>Environment — Navigation</th>
<th>Environment — Weather</th>
<th>Environment — Aerodromes and Terrain</th>
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## 15. IO — MASTER MATRIX DATA

### 15.1 IO — Master matrix data — Training (T) — The introduction of a specific training task

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## Part I. Training Task Derived Flight Simulation Requirements

### Appendix C. FSTD master matrix

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<td>One Engine inoperative, en-route</td>
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### 16. ATPL — MASTER MATRIX DATA

#### 16.1 ATPL — Master matrix data — Training (T) — The introduction of a specific training task

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<th>Ground Handling</th>
<th>A/C Systems</th>
<th>Flight controls and forces</th>
<th>Sound Cue</th>
<th>Visual Cue</th>
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**ICAO** International Civil Aviation Organization

**FAA** Federal Aviation Administration
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### 16.2 ATPL — Master matrix data — Training-to-Proficiency (TP)

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### Part I. Training Task Derived Flight Simulation Requirements

#### Appendix C. FSTD master matrix I-App C-87

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<td>Fire/smoke in aircraft</td>
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<td>Emergency descent (maximum rate)</td>
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<td>Engine fire, severe damage, or separation</td>
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<td>Landing with degraded flight controls</td>
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<td>Pilot incapacitation</td>
<td>S  S  S  S  S  R  N  R  R  N  R  N</td>
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<td>All other emergencies as in the FCOM</td>
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<td>MISC</td>
<td>Manual Precision Approach without Flight Director</td>
<td>S  S  N  S  S  R  S  R  S  S  N  R</td>
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Chapter 1

GLOSSARY OF TERMS, ABBREVIATIONS AND UNITS

1.1 GLOSSARY OF TERMS

The terms used in this Part of the Manual have the following meanings:

**Active force feedback.** In the context of a Flight Controls System, active force feedback indicates that the aeroplane control forces may have a dependency upon flight conditions.

**Additional engines/avionics.** An FSTD which has simulation of more than one engine/avionics fit.

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

  Note.— An example is the data used to generate Aeroplane Flight Manual (AFM) or Flight Planning and Cruise Control Manual (FPCCM) values.

**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.

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

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

**Alternate engines/avionics.** An FSTD which has simulation of a replacement engine/avionics fit.

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

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

  Note.— For additional guidance, see the guidance material in the Attachments to this Part of the manual and related reading material listed in Chapter 2, 2.3, of this Part.

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

**Approved use.** The ability to complete the training, testing or checking tasks as prescribed in this document.

**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.** An aeroplane manufacturer’s engineering simulator which has undergone a review by the appropriate NAA and been found to be an acceptable source of supplemental validation data.
Automatic testing. FSTD testing wherein all stimuli are under computer control.


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

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

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 their use may be dependent on the outcome of the event, e.g. a step towards a licence issuance, a recurrent evaluation of competency.

Class of aeroplane. In relation to the classification of aeroplanes, means aeroplanes having similar operating characteristics.

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 aeroplane (CCA). An aeroplane where pilot inputs to the control surfaces are transferred and augmented via computers.

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

Convertible FSTD. An FSTD in which significant hardware, software, or a combination of both are changed so that the device becomes a replica of a different model, type or variant, usually of the same aeroplane. The same FSTD platform, motion system, 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 necessary. Otherwise, a supplemental section added to the original QTG may suffice.

Correct trend and magnitude. A tolerance meaning the appropriate general direction of movement of the aeroplane, 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 propulsive force 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.

**Daylight visual.** A visual system capable of meeting, as a minimum, the system brightness and contrast ratio requirements as identified in Appendix B.

**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 qualified to the same level.

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

**Engineering simulator validation data.** Validation data generated by an engineering simulation or engineering simulator that is 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 level 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.

**Flight simulation training device (FSTD).** A synthetic training device that is in compliance with the minimum requirements for FSTD qualification as described in this manual.

**Flight test data.** Actual aeroplane data obtained by the aeroplane manufacturer (or other approved supplier of data) during an aeroplane flight test programme.

**FSTD approval.** Declaration of the extent to which an FSTD of a specified qualification level may be used by an operator or training organization as agreed by the NAA. It takes account of differences between aeroplanes 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 13 categories that have been used in Appendix A of Part II of this manual for the definition of the General and Technical Requirements for FSTDs.

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

**FSTD qualification level.** The level of technical capability of an FSTD.

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

**Footprint test.** A test conducted and recorded on an FSTD to be used as reference.

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

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

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

**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 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 aeroplane under normal and non-normal conditions.

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

**Ground effect.** The change in aerodynamic characteristics due to modification of the airflow past the aeroplane, caused by proximity to the ground.

**Ground reaction.** Forces acting on the aeroplane due to contact with the ground. These forces should include the effects of strut deflections, tire friction, side forces, structural contact and other appropriate aspects. These forces should change appropriately, for example, with weight and speed.

**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.** Operating mass at or near the maximum for the specified flight condition.

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

**Highlight brightness.** The maximum displayed brightness.

**Icing accountability.** Refers to changes from normal (as applicable to the individual aeroplane design) in take-off, climb (en-route, approach, landing) or landing operating procedures or performance data, in accordance with the Aeroplane Flight Manual, for flight in icing conditions or with ice accumulation on unprotected surfaces.
Integrated testing. Testing of the FSTD such that all aeroplane system models are active and contribute appropriately to the results. None of the aeroplane system models should be substituted with models or other algorithms intended for testing purposes only. This 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.

International Committee for FSTD Qualification (ICFQ). A committee of the Royal Aeronautical Society that reviews proposals for updating this manual.

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

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

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

Light gross mass. A mass chosen by the sponsor or data provider that is not more than 120 per cent of the basic operating mass (BOM) of the aeroplane being simulated or as limited by the minimum practical operating mass of the test aeroplane.

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. Normal operating mass for the flight condition.

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

Near maximum gross mass. A mass chosen by the sponsor or data provider that is not less than the BOM of the aeroplane being simulated plus 80 per cent of the difference between the maximum certificated mass (either take-off mass or landing mass, as appropriate for the test) and the BOM.

Night visual. A visual system capable of producing, as a minimum, all features applicable to the twilight scene (see Twilight (dusk/dawn) visual) with the exception of the need to portray reduced ambient intensity which removes ground cues that are not self-illuminating or illuminated by own ship lights (e.g. landing lights).

Nominal. Normal operating 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 aeroplanes.

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

Normal control. A state where the intended control, augmentation and protection functions are fully available. Used in reference to computer-controlled aeroplanes.
**Objective test.** A quantitative assessment based on comparison to objective data.

**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, passive force feedback indicates that the aeroplane control forces do not have a dependency upon flight conditions, e.g., the flight controls forces may be provided by a spring, or spring and damper arrangement.

**Protection functions.** Systems functions designed to protect an aeroplane 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 manual.

**Representative (R).** The intermediate level of required fidelity for a given FSTD feature.

**Reversible control system.** A control system in which movement of the control surface will back drive the pilot’s control on the flight deck.

**Second segment.** That portion of the take-off profile from after gear retraction to end of climb at $V_2$ and the beginning of the acceleration segment (initial flap/slat retraction).

**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.

**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.

**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) on the flight deck, which also may be referred to as TLA or power lever angle or throttle angle.

**Time history.** The presentation of the change of a variable with respect to time.
Train. 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. 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 aeroplane 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 aeroplane simulated.

Twilight (dusk/dawn) visual. A visual system capable of producing, as a minimum, full-colour presentations of reduced ambient intensity, sufficient surfaces with appropriate textural cues that include self-illuminated objects such as road networks, ramp lighting and airport signage.

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

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

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

Validation data roadmap (VDR). A document from the aeroplane 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 thrust rating and the revision levels of all avionics that affect aeroplane handling qualities and performance. See Attachment D to this manual.

Validation flight test data. Performance, stability and control, and other necessary test parameters, electrically or electronically recorded in an aeroplane using a calibrated data acquisition system of sufficient resolution and verified as accurate 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.

Visual ground segment. The visible distance on the ground, between the lower cut-off of the aeroplane cockpit and the furthest visible point, as limited by the prevailing visibility.
1.2 ABBREVIATIONS AND UNITS

The abbreviations and units used in Part II of this manual have the following meaning:

- \( A_t \): 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)
- ACARS: Aircraft Communication Addressing and Reporting System
- AGL: Above Ground Level (m or ft)
- AOA: Angle of Attack (degrees)
- APU: Auxiliary Power Unit
- APV: Approach Procedures with Vertical guidance
- ASOS: Automated Surface Observation System
- ATA: Air Transport Association
- ATC: Air Traffic Control
- ATIS: Automatic Terminal Information System
- ATN: Aeronautical Telecommunication Network
- ATPL: Airline Transport Pilot Licence (Certificate or Type Rating)
- AWOS: Automated Weather Observing System

- 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
- CCA: Computer-Controlled Aeroplane
- CCD: Charge-Coupled Device
- \( \text{cd/m}^2 \): Candela/metre\(^2\) (3.4263 candela/m\(^2\) = 1 ft-Lambert)
- CFIT: Controlled Flight Into Terrain
- cg: Centre of gravity
- cm: Centimetre(s)
- CPL: Commercial Pilot Licence
- CQ: Continuing Qualification
- CR: Class Rating
- ctd: continued
- CT&M: Correct Trend and Magnitude
- daN: DecaNewtons
- dB: Decibel
- dBSPL: Decibel, Sound Pressure Level
- DH: Decision Height
- DME: Distance Measuring Equipment
- DOF: Degrees of Freedom
- EASA: European Aviation Safety Agency
- EFIS: Electronic Flight Instrument System
- EFVS: Enhanced Flight Vision System
- EPR: Engine Pressure Ratio
- eQTG: Electronic Qualification Test Guide
Part II. Flight Simulation Training Device Criteria
Chapter 1. Glossary of terms, abbreviations and units

FAA Federal Aviation Administration (United States of America)
FANS Future Air Navigation System
FCL Flight Crew Licensing
FCOM Flight Crew Operations Manual (or Operating Manual)
FPCCM Flight Planning and Cruise Control Manual
FPTD Flight Procedures Training Device
FSTD Flight Simulation Training Device
FOV Field of View
ft Foot (1 ft = 0.304801 m)
ft-Lambert Foot-lambert (1 ft-Lambert = 3.4263 candela/m²)

G Generic (as related to fidelity level)
g Acceleration due to gravity (m/s² or ft/s²; 1 g = 9.81 m/s² or 32.2 ft/s²)
GBAS Ground-Based Augmentation System
GNSS Global Navigation Satellite System
GPS Global Positioning System
G/A Go-Around
G/S Glide Slope

HGS Head-up Guidance System
HUD Head-Up Display
Hz Unit of frequency (1 Hz = one cycle per second)

IAS Indicated Airspeed
IATA International Air Transport Association
ICAO International Civil Aviation Organization
ICFQ International Committee for FSTD Qualification
ILS Instrument Landing System
IO Initial Operator training and checking
IOS Instructor Operating Station
IPOM Integrated Proof of Match
IR Initial Instrument Rating

JAA European Joint Aviation Authorities
JAWS Joint Airport Weather Studies

km Kilometre(s) (1 km = 0.621 37 statute mile)
kPa KiloPascal (kilonewton/m²) (1 psi = 6.894 76 kPa)
kt Knots calibrated airspeed unless otherwise specified (1 knot = 0.5144 m/s or 1.688 ft/s)

lb Pound(s) (1 lb = 0.453 59 kg)
lbf Pound-force (1 lbf = 4.448 2 newton)
LOC-BC ILS localizer Back Course
LOC/LLZ ILS localizer
LOFT Line-Oriented Flight Training
LOS Line-Oriented Simulation
m  
MCQFSTD  
MCTM  
MDA  
min  
MLG  
MLS  
MPa  
MPL  
MQTG  
ms  

N  
n  
N1  
N2  
NAA  
NDB  
NM  
NN  
NWA  

OAT  
OMCT  
OTD  

P0  

P1  

P2  

Pf  

Pn  

PANS  
PAPI  
PAR  
pitch  
PLA  
PLF  
POM  
PPL  
PRM  
PSD  
psi  

QFE  
QNH  
QRH  
QTG
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>Representative (as related to fidelity level)</td>
</tr>
<tr>
<td>RAE</td>
<td>Royal Aerospace Establishment</td>
</tr>
<tr>
<td>RAeS</td>
<td>Royal Aeronautical Society</td>
</tr>
<tr>
<td>RAT</td>
<td>Ram Air Turbine</td>
</tr>
<tr>
<td>R/C</td>
<td>Rate of Climb (m/s or ft/min) (1 ft/min = 0.005 08 m/s)</td>
</tr>
<tr>
<td>R/D</td>
<td>Rate of Descent (m/s or ft/min)</td>
</tr>
<tr>
<td>Re</td>
<td>Recency (take off and landing)</td>
</tr>
<tr>
<td>REIL</td>
<td>Runway End Identifier Lights</td>
</tr>
<tr>
<td>RL</td>
<td>Recurrent Licence Training and Checking</td>
</tr>
<tr>
<td>RMS</td>
<td>Root Mean Square</td>
</tr>
<tr>
<td>RNAV</td>
<td>Area Navigation</td>
</tr>
<tr>
<td>RO</td>
<td>Recurrent Operator Training and Checking</td>
</tr>
<tr>
<td>RPM</td>
<td>Revolutions per Minute</td>
</tr>
<tr>
<td>RTO</td>
<td>Rejected Take-Off</td>
</tr>
<tr>
<td>RVR</td>
<td>Runway Visual Range (m or ft)</td>
</tr>
<tr>
<td>S</td>
<td>Specific (as related to fidelity level)</td>
</tr>
<tr>
<td>s</td>
<td>Second(s)</td>
</tr>
<tr>
<td>SBAS</td>
<td>Satellite-Based Augmentation System</td>
</tr>
<tr>
<td>sm</td>
<td>Statute Mile(s) (1 statute mile = 1 609 m = 5 280 ft)</td>
</tr>
<tr>
<td>SMGCS</td>
<td>Surface Movement Guidance and Control System</td>
</tr>
<tr>
<td>SOC</td>
<td>Statement of Compliance</td>
</tr>
<tr>
<td>SPL</td>
<td>Sound Pressure Level</td>
</tr>
<tr>
<td>SUPPS</td>
<td>Regional Supplementary Procedures</td>
</tr>
<tr>
<td>T</td>
<td>Train(ing)</td>
</tr>
<tr>
<td>T_f</td>
<td>Total time of the flare manoeuvre duration</td>
</tr>
<tr>
<td>T_i</td>
<td>Total time from initial throttle movement until a 10 per cent response of a critical engine parameter</td>
</tr>
<tr>
<td>T_t</td>
<td>Total time from initial throttle movement to a 90 per cent increase or decrease in the power level specified</td>
</tr>
<tr>
<td>T(A)</td>
<td>Tolerance applied to amplitude</td>
</tr>
<tr>
<td>T(Ad)</td>
<td>Tolerance applied to residual amplitude</td>
</tr>
<tr>
<td>TACAN</td>
<td>Tactical Air Navigation</td>
</tr>
<tr>
<td>TBD</td>
<td>To Be Determined</td>
</tr>
<tr>
<td>TCAS</td>
<td>Traffic alert and Collision Avoidance System</td>
</tr>
<tr>
<td>TGL</td>
<td>Temporary Guidance Leaflet</td>
</tr>
<tr>
<td>TLA</td>
<td>Throttle (Thrust) Lever Angle</td>
</tr>
<tr>
<td>T/O</td>
<td>Take-Off</td>
</tr>
<tr>
<td>TP</td>
<td>Train(ing)-to-Proficiency</td>
</tr>
<tr>
<td>T(P)</td>
<td>Tolerance applied to period</td>
</tr>
<tr>
<td>TR</td>
<td>Type Rating Training and Checking</td>
</tr>
<tr>
<td>TRG</td>
<td>Training</td>
</tr>
<tr>
<td>UTC</td>
<td>Coordinated Universal Time</td>
</tr>
<tr>
<td>V_1</td>
<td>Decision speed</td>
</tr>
<tr>
<td>V_2</td>
<td>Take-off safety speed</td>
</tr>
<tr>
<td>V_mca</td>
<td>Minimum control speed (air)</td>
</tr>
<tr>
<td>V_mcg</td>
<td>Minimum control speed (ground)</td>
</tr>
<tr>
<td>V_mcl</td>
<td>Minimum control speed (landing)</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>$V_{mo}$</td>
<td>Maximum operating speed</td>
</tr>
<tr>
<td>$V_{mu}$</td>
<td>Minimum unstick speed</td>
</tr>
<tr>
<td>$V_r$</td>
<td>Rotate speed</td>
</tr>
<tr>
<td>$V_s$</td>
<td>Stall speed or minimum speed in the stall</td>
</tr>
<tr>
<td>VASI</td>
<td>Visual Approach Slope Indicator system</td>
</tr>
<tr>
<td>VDR</td>
<td>Validation Data Roadmap</td>
</tr>
<tr>
<td>VFR</td>
<td>Visual Flight Rules</td>
</tr>
<tr>
<td>VGS</td>
<td>Visual Ground Segment</td>
</tr>
<tr>
<td>VHF</td>
<td>Very High Frequency</td>
</tr>
<tr>
<td>VOR</td>
<td>VHF Omnidirectional Radio Range</td>
</tr>
<tr>
<td>WAT</td>
<td>Weight, Altitude, Temperature</td>
</tr>
</tbody>
</table>
Chapter 2

INTRODUCTION

2.1 PURPOSE

2.1.1 Part II of this Volume establishes the performance and documentation requirements for evaluation by NAAs of seven (7) standard aeroplane 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 Part II of this Volume 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, Part II 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 aeroplanes also have encouraged broader use of advanced simulation. FSTDs can provide more in-depth training than can be accomplished in aeroplanes and provide a safe and suitable learning environment. Fidelity of modern FSTDs is sufficient to permit pilot assessment with assurance that the observed behaviour will transfer to the aeroplane. 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 manual. 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 MPL content is preliminary and offers a means by which the device requirements may be satisfied but should not be treated as the only means by which the device requirements of an MPL programme may be met. The relevant text in this manual will be updated when the pertinent information from the completion of the MPL programmes implementation phase becomes available.

2.2.4 The summary matrix defines the FSTD Types by correlating training types against fidelity levels for key simulation features. Each of the 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 level of fidelity of device feature is defined as follows:

2.2.4.1 Training types:

- MPL1 Multi-crew Pilot Licence – Phase 1, Core flying skills;
- MPL2 Multi-crew Pilot Licence – Phase 2, Basic;
- MPL3 Multi-crew Pilot Licence – Phase 3, Intermediate;
- MPL4 Multi-crew Pilot Licence – Phase 4, Advanced;
IR Initial Instrument Rating;
PPL Private Pilot Licence;
CPL Commercial Pilot Licence;
TR Type Rating Training and Checking;
ATPL Airline Transport Pilot Licence or Certificate;
CR Class Rating;
RL Recurrent Licence Training and Checking;
RO Recurrent Operator Training and Checking;
IO Initial Operator Training and Checking;
CQ Continuing Qualification; and
Re Recency (Take-off and Landing).

2.2.4.2 FSTD features:

Flight Deck Layout and Structure
Flight Model (Aerodynamics and Engine)
Ground Handling
Aeroplane Systems (ATA)
Flight Controls and Forces

Sound Cues
Visual Cues
Motion Cues

Environment (ATC)
Environment (Navigation)
Environment (Weather)
Environment (Airports and Terrain)

Miscellaneous — (Instructor Operating Station, etc.)

2.2.4.3 Device feature fidelity level:

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

For a detailed definition of S, R, G and N please refer to Chapter 1, Section 1.1, Fidelity level.

2.2.5 Training codes:

2.2.5.1 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.

2.2.5.2 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>
<thead>
<tr>
<th>DEVICE TYPE</th>
<th>LICENCE OR TYPE OF TRAINING</th>
<th>DEVICE FEATURE</th>
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<tbody>
<tr>
<td>Type VII</td>
<td>MPL4 – Advanced</td>
<td>T + TP</td>
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<tr>
<td></td>
<td>TR/ATPL</td>
<td>TP</td>
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<tr>
<td></td>
<td>Re</td>
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<td>RL/RO/IO/CQ</td>
<td>TP</td>
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<tr>
<td>Type VI</td>
<td>MPL3 – Intermediate</td>
<td>T + TP</td>
</tr>
<tr>
<td>Type V</td>
<td>TR/ATPL/RL/RO/IO</td>
<td>T</td>
</tr>
<tr>
<td>Type IV</td>
<td>MPL2 – Basic</td>
<td>T + TP</td>
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<tr>
<td>Type III</td>
<td>CR</td>
<td>T</td>
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<tr>
<td>Type II</td>
<td>IR</td>
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<td>Train (T) or Train-to-Ps (TP)</td>
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<td>Train (T) or Train-to-Ps (TP)</td>
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<td>DEVICE TYPE</td>
<td>LICENCE OR TYPE OF TRAINING</td>
<td>DEVICE FEATURE</td>
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<td>Type I</td>
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<tr>
<td>CPL</td>
<td>T</td>
<td>R R R R R G R N N S G G(S)</td>
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<tr>
<td>MPL1 – Core flying skills</td>
<td>T</td>
<td>R R R R R R1 G G N N S G G</td>
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2.2.6 Notes for special cases in Table 2-1:

2.2.6.1 For Environment – ATC: the fidelity level S in the summary matrix above is shown greyed out as this level of fidelity is currently under development based on an urgent need by the FSTD users. 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).

2.2.6.2 Type VI – MPL3 – Intermediate: MPL Phase 3 learning outcomes are not specific to aeroplane type. The Type VI FSTD example indicated in the summary matrix for MPL Phase 3 offers a means, but not the only means, by which the FSTD specifications support the training outcomes. The task analysis indicates the possibility to meet competency outcomes by a combination of training in the Type V and Type VII FSTD examples. The summary of the Type VI device example is deliberately “greyed out”, representing a class-like device specification, to meet the learning outcomes in Phase 3, with a representative high-performance multi-engine turbine aeroplane. Furthermore, the definition of this device type has not been confirmed by the ICAO MPL process. The relevant text in this manual may be updated when the pertinent information from the completion of the MPL programmes implementation phase becomes available, allowing this device type to be finally defined.

2.2.6.3 Type VI – MPL3 – Intermediate – Motion Cue – R1: the pilot receives an effective and representative motion cue and stimulus, which provides the appropriate sensations of acceleration of the aeroplane 6 degrees of freedom. Motion cues should always provide the correct sensation. These sensations may be generated by a variety of methods which are specifically not prescribed. The sensation of motion can be less for simplified non-type specific training, the magnitude of the cues being reduced.

2.2.6.4 Type I – CPL – Environment Airports and Terrain – G(S): level S if required for specific VFR cross-country navigation training.

2.2.6.5 Type I – PPL – Environment Airports and Terrain – R(S): level S if required for specific VFR cross-country navigation training.

2.2.6.6 Type I – MPL1 – Core flying skills – Flight Controls and Forces – R1: aeroplane like, derived from class, appropriate to aeroplane mass. Active force feedback not required.

2.2.6.7 The “Miscellaneous” category does not appear in the table.

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

2.2.8 The preceding process resulted in the seven defined 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 attain the seven pre-defined device types. In very simple terms, one determines the training tasks, then selects 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 using this process, the appropriate NAA should be consulted very early.

2.3 RELATED READING MATERIAL

2.3.1 Applicants seeking FSTD evaluation, qualification and approval for use of aeroplane FSTDs 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.

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

ICAO

Annex 1 – Personnel Licensing, Amendment 167;
Doc 4444, Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM); and

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


JAA

JAR-FSTD A, Aeroplane Flight Simulation Training Devices;
JAR-FSTD H, Helicopter Flight Simulation Training Devices;
JAR-STD 1H, 2H, 3H: Helicopter Flight Simulators, Flight Training Devices, Flight & Navigational Procedure Trainers; and
FCL TGL #7, Multi-crew Pilot Licence Training – Air Traffic Control Environment Simulation.

United Kingdom


United States

14 CFR FAR Part 60, Requirements for the Evaluation, Qualification & Maintenance of Flight Simulation Training Devices;
Advisory Circular 120-40B, Aeroplane Simulator Qualification;
Advisory Circular 120-40B, (International) Aeroplane Simulator Qualification;
Advisory Circular 120-45A, Aeroplane Flight Training Device Qualification;
Advisory Circular 120-63, Helicopter Simulator Qualification; and

2.3.3 Additional related documents are:

International Air Transport Association (IATA):
Flight Simulator Design and Performance Data Requirements, 6th Edition, 2000; and

Royal Aeronautical Society publications:
2.3.4 It is important to regularly monitor Regulatory Guidance Material on the NAA web sites to understand the latest regulatory opinion on new technology or practices.

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 level 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, the FSTD performance could not be verified in the time normally available for the authority 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 and its 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 oversight of the activities of the user of the FSTD can approve 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, climb, cruise, descent, approach and landing; all-weather operations; control checks; and pilot, flight engineer and instructor station functions checks. The motion, 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 of this Part and the functions and subjective tests in Appendix C. Validation tests are used to compare objectively FSTD and aeroplane data to ensure that they agree within specified tolerances. Functions tests are objective tests of systems using aeroplane documentation. Subjective tests provide a basis for evaluating the 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 of 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 aeroplane type, the aeroplane 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 a class of aeroplane with the exception of aeroplane type specific FSTDs (Type V sound system and Type VII sound and motion systems) where these evaluations are against aeroplane type specific data. For initial evaluation of FSTDs representing a class of aeroplane, the aeroplane 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 and sound systems, 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 and sound systems.

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

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 aeroplane within the class of aeroplanes the FSTD is representing or it may be based on information from several aeroplanes within the class. 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 shall show that the proposed validation data are representative of the aeroplane or the class of aeroplanes modelled. This report may include flight test data, manufacturer’s design data, information from the aeroplane flight manual (AFM) 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 aeroplane programmes, the aeroplane manufacturer’s data, partially validated by flight test data, may be used in the interim qualification of the FSTD. However, the FSTD should be re-qualified following the release of the manufacturer’s data resulting from the type certification of the aeroplane. The re-qualification schedule should be as agreed by the NAA, the FSTD operator, the FSTD manufacturer and the aeroplane manufacturer. For additional information, refer to Attachment A.

2.5.7 FSTD operators seeking initial or upgrade evaluation of an FSTD should be aware that performance and handling data for older aeroplanes may not be of sufficient quality to meet some of the test standards contained in this manual. 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.

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 manual.

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) aeroplane model and series or class, as applicable, being simulated;

3) FSTD qualification level;

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 a documented acceptance testing procedure covering cockpit layout, all simulated aeroplane 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) aeroplane model and series or class, 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) a minimum of three designated qualification scenes; and
   13) 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 test;

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 this Part 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 this Part:
   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 aeroplane 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 flight deck 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 aeroplane 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:

    a) be computer generated;

    b) be produced on appropriate media acceptable to the authority conducting the test;

    c) be time histories unless otherwise indicated and:

       i) should plot for each test the list of recommended parameters contained in the “Aeroplane Flight Simulator Evaluation Handbook”, Volume I (see 2.3.2);

       ii) be clearly marked with appropriate time reference points to ensure an accurate comparison between FSTD and aeroplane;

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

       iv) 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”;

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

    e) have each page reflect the date and time completed;
f) have each page reflect the test page number and the total number of pages in the test;

g) have parameters with specified tolerances identified, with tolerance criteria and units given. Automatic flagging of “out-of-tolerance” situations is encouraged; and

h) have incremental scales on graphical presentations that provide the resolution necessary for evaluation of the parameters shown in Appendix B of this Part;

13) Validation data.

a) 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;

b) Aeroplane 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

c) 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; and

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.

2.6.3 The QTG will provide the documented proof of compliance with the FSTD validation tests in Appendix B of this Part. FSTD test results should be labelled using terminology common to aeroplane parameters as opposed to computer software identifications. These results should be easily compared with the supporting data by employing overplotting or other acceptable means. For tests involving time histories, the overplotting of the FSTD data to aeroplane 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 After the initial evaluation, the MQTG is 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 (May 15th, 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 manual.

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

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 level; 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 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.

2.11.1.3 The request for evaluation should also include a statement that the FSTD has been thoroughly tested using a documented acceptance testing procedure covering cockpit layout, all simulated aeroplane 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 manual. The applicant should further certify that all the QTG tests for the requested qualification level have been satisfactorily conducted.
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 level. 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 level.

2.11.2.3 An upgrade is defined as the raising of the qualification level 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 level 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 only applicable when the operator requests a higher qualification level 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.

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 level.

2.11.4 Moving an FSTD to a new 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 what amount 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 Composition of an evaluation team

2.11.5.1 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 type-qualified pilot.

2.11.5.2 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.

2.11.5.3 On an initial evaluation, the FSTD manufacturer and/or aeroplane manufacturer should have technical staff available to assist as required.
2.11.6 FSTD qualification basis

2.11.6.1 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.

2.11.6.2 The NAA having jurisdiction over the FSTD should establish the time interval required for the recurrent evaluation.

2.12 ADOPTION OF THIS MANUAL INTO THE REGULATORY FRAMEWORK

The application of this manual and amendments into the regulatory framework is the responsibility of the various National Aviation Authorities (NAA) through their regulatory documents such as FAR Part 60, JAR-FSTD A or other equivalent document (see 2.3.2).

2.13 FUTURE UPDATES OF THIS MANUAL

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

2.14 EVALUATION HANDBOOKS

The Aeroplane Flight Simulator Evaluation Handbook, as amended, is 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 manual. This two-volume document can be obtained through the Royal Aeronautical Society (see 2.3.2).
Appendix A

FSTD REQUIREMENTS

INTRODUCTION

This appendix describes the minimum flight simulator training device (FSTD) requirements for qualifying a device to the agreed international Type, as defined in Table 2-1 of Chapter 2, 2.2 of this Part. The validation tests and functions and subjective tests listed in Appendices B and C of 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, such as gear modelling approach, coefficient of friction sources, etc.
1. REQUIREMENT — FLIGHT DECK LAYOUT AND STRUCTURE

| 1.S | An enclosed full scale replica of the aeroplane cockpit/flight deck, which will have fully functional controls, instruments and switches to support the approved use. Anything not required to be accessed by the flight crew during normal, abnormal, emergency and, where applicable, non-normal operations does not need to be functional. | ✓ | ✓ | ✓ |
| 1.R | An enclosed or perceived to be enclosed cockpit/flight deck, excluding distraction, which will represent that of the aeroplane derived from, and appropriate to class, to support the approved use. | ✓ | ✓ | ✓ | ✓ |
| 1.G | An open, enclosed or perceived to be enclosed, cockpit/flight deck, excluding distraction, which will represent that of the aeroplane derived from, and appropriate to class, to support the approved use. | ✓ |

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<tr>
<th>1.1</th>
<th>FEATURE TECHNICAL REQUIREMENT COCKPIT/FLIGHT DECK LAYOUT AND STRUCTURE</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
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<tr>
<td>1.1.S.a</td>
<td>An enclosed, full scale replica of the cockpit/flight deck of the aeroplane being simulated.</td>
<td>✓</td>
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<tr>
<td>1.1.S.b</td>
<td>An enclosed, full scale replica of the cockpit/flight deck of the aeroplane being simulated except the enclosure need only extend to the aft end of the cockpit/flight deck area.</td>
<td>✓</td>
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FEATURE TECHNICAL REQUIREMENT
COCKPIT/FLIGHT DECK LAYOUT AND STRUCTURE

| 1.1.S.c | An enclosed, full scale replica of the cockpit/flight deck of the aeroplane being simulated including all: structure and panels; primary and secondary flight controls; engine and propeller controls, as applicable; equipment and systems with associated controls and observable indicators; circuit breakers; flight instruments; navigation, communications and similar use equipment; caution and warning systems and emergency equipment. The tactile feel, technique, effort, travel and direction required to manipulate the preceding, as applicable, should replicate those in the aeroplane.

As applicable, equipment for operation of the cockpit/flight deck windows should be included but the actual windows need not be operable.

Additional required flight crew member duty stations and those bulkheads aft of the pilots’ seats containing items such as switches, circuit breakers, supplementary radio panels, etc., to which the flight crew may require access during any event after pre-flight cockpit/flight deck preparation is complete, are also considered part of the cockpit/flight deck and should replicate the aeroplane.

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<tr>
<th>Type I</th>
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Aeroplane observer seats are not considered to be additional flight crew member duty stations and may be omitted.

Any items required by the training program, including those required to complete the pre-flight checklist, should be available but may be relocated to a suitable location as near as possible to the original position. An accurate facsimile of emergency equipment items, such as a three dimensional model or a photograph, is acceptable provided the facsimile is modelled or is operational to the extent required by the training program.

Exceptions to this policy may be acceptable on a case by case basis following coordination with the respective NAA. Coordination should be concluded during the simulator design phase.

Aeroplane observer seats are not considered to be additional flight crew member duty stations and may be omitted.

The use of electronically displayed images with physical overlay or masking for FSTD instruments and/or instrument panels is acceptable provided:

Note.— The cockpit/flight deck, 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.
<table>
<thead>
<tr>
<th>FEATURE TECHNICAL REQUIREMENT COCKPIT/FLIGHT DECK LAYOUT AND STRUCTURE</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMENTS</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tbody>
</table>

- all instruments and instrument panel layouts are dimensionally correct with differences, if any, being imperceptible to the pilot;
- instruments replicate those of the aeroplane including full instrument functionality and embedded logic;
- instruments displayed are free of quantization (stepping);
- instrument display characteristics replicate those of the aeroplane including: resolution, colours, luminance, brightness, fonts, fill patterns, line styles and symbology;
- overlay or masking, including bezels and bugs, as applicable, replicates the aeroplane panel(s);
- instrument controls and switches replicate and operate with the same technique, effort, travel and in the same direction as those in the aeroplane;
- instrument lighting replicates that of the aeroplane and is operated from the FSTD control for that lighting and, if applicable, is at a level commensurate with other lighting operated by that same control;
- as applicable, instruments should have faceplates that replicate those in the aeroplane; and
- Type VII only:
  - as for Type V above, and
  - the display image of any three dimensional instrument, such as an electro-mechanical instrument, should appear to have the same
<table>
<thead>
<tr>
<th>FEATURE TECHNICAL REQUIREMENT COCKPIT/FLIGHT DECK LAYOUT AND STRUCTURE</th>
<th>Type I</th>
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<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
</tr>
</thead>
</table>
| 1.1.R An enclosed, or perceived to be enclosed, spatially representative cockpit/flight deck of the aeroplane or class of aeroplanes being simulated including representative; primary and secondary flight controls; engine and propeller controls as applicable; systems and controls; circuit breakers; flight instruments; navigation and communications equipment; and caution and warning systems. The technique, effort, travel and direction required to manipulate the preceding, as applicable, should be representative of those in the aeroplane or class of aeroplanes.  

Note 1.— The cockpit/flight deck enclosure need only be representative of that in the aeroplane or those in the class of aeroplanes being simulated and should include windows.  

Note 2.— The enclosure need only extend to the aft end of the cockpit/flight deck. | ✓* | ✓ | ✓ | ✓ | | | |

Comments: three-dimensional depth as the replicated instrument. The appearance of the simulated instrument, when viewed from any angle, should replicate that of the actual aeroplane instrument. Any instrument reading inaccuracy due to viewing angle and parallax present in the actual aeroplane instrument should be duplicated in the simulated instrument display image.

FSTD instruments and/or instrument panels using electronically displayed images with physical overlay or masking and operable controls representative of those in the aeroplane are acceptable. The instruments displayed should be free of quantization (stepping).

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 class representative form, and be functionally accurate.

With the requirement for only a spatially representative cockpit/flight deck, the physical dimensions of the enclosure may be acceptable to simulate more than one aeroplane or class of aeroplanes in a convertible FSTD. Each FSTD conversion should be representative of the aeroplane or class of aeroplanes being simulated which may require some controls, instruments, panels, masking, etc. to be changed for some conversions.

* If the FSTD is used for VFR training, it should be a representation of the aeroplane or class of aeroplanes comparable to the actual aeroplane used for flight training.
<table>
<thead>
<tr>
<th>FEATURE TECHNICAL REQUIREMENT</th>
<th>Type I</th>
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<th>Type III</th>
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<th>Type VI</th>
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</thead>
<tbody>
<tr>
<td>COCKPIT/FLIGHT DECK LAYOUT AND STRUCTURE</td>
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<td>COMMENTS</td>
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<tr>
<td>1.1.G An open, enclosed or perceived to be enclosed cockpit/flight deck area with aeroplane-like primary and secondary flight controls; engine and propeller controls as applicable; equipment; systems; instruments; and associated controls, assembled in a spatial manner to resemble that of the aeroplane or class of aeroplanes 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 a representative design eye position.</td>
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<td>The assembled components should be compatible and function in a cohesive manner.</td>
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<td>FSTD 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).</td>
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<td></td>
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<td></td>
<td>Only those circuit breakers used in a normal, abnormal or emergency procedure need to be presented, simulated in an aeroplane-like form, and be functionally accurate.</td>
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<td>Note.— Aeroplane-like controls, instruments and equipment means as for the aeroplane or class of aeroplanes being simulated. If the FSTD is convertible, some may have to be changed for some conversions.</td>
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<tr>
<td>1.2 SEATING</td>
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<tr>
<td>1.2.1.S Flight crew member seats should replicate those in the aeroplane being simulated.</td>
<td></td>
<td></td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>1.2.1.R Flight crew member seats should represent those in the aeroplane being simulated.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>1.2.1.G 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 aeroplane or class of aeroplanes.</td>
<td>✓</td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT COCKPIT/FLIGHT DECK LAYOUT AND STRUCTURE</td>
<td>Type I</td>
<td>Type II</td>
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<tr>
<td>1.2.2.S.a 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. The location of at least one of these seats should provide an adequate view of the pilots' panels and forward windows.</td>
<td>✓</td>
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<td>✓</td>
</tr>
<tr>
<td>1.2.2.S.b 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.</td>
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<td>✓</td>
</tr>
<tr>
<td>1.2.2.R In addition to the flight crew member seats, there should be an instructor station seat and two suitable seats for an observer and an authority inspector.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2.2.G In addition to the flight crew member seats, there should be an instructor station seat and two suitable seats for an observer and an authority inspector.</td>
<td>✓</td>
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<tr>
<td>1.3 COCKPIT/FLIGHT DECK LIGHTING</td>
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<tr>
<td>1.3.S Cockpit/flight deck lighting should replicate that in the aeroplane</td>
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<td>✓</td>
</tr>
<tr>
<td>1.3.R Lighting environment for panels and instruments should be sufficient for the operation being conducted</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>1.3.G Lighting environment for panels and instruments should be sufficient for the operation being conducted.</td>
<td>✓</td>
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</tbody>
</table>
### 2. REQUIREMENT — FLIGHT MODEL

<table>
<thead>
<tr>
<th>Type</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Aerodynamic and engine modelling for all combinations of drag and thrust, including the effects of change in aeroplane attitude, sideslip, altitude, temperature, gross mass, centre of gravity location and configuration to support the approved use. Should address ground effect, mach effect, aeroelastic representations, non-linearities due to sideslip, effects of airframe icing, forward and reverse dynamic thrust effect on control surfaces. Realistic aeroplane mass properties, including mass, centre of gravity and moments of inertia as a function of payload and fuel loading should be implemented.</td>
</tr>
<tr>
<td>II</td>
<td>Aerodynamic and engine modelling, aeroplane-like, derived from and appropriate to class to support the approved use. Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight corresponding to actual flight conditions, including the effect of change in aeroplane attitude, sideslip, thrust, drag, altitude, temperature.</td>
</tr>
<tr>
<td>III</td>
<td>Aerodynamic and engine modelling, aeroplane-like, to support the approved use. Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight corresponding to actual flight conditions, including the effect of change in aeroplane attitude, sideslip, thrust, drag, altitude, temperature.</td>
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<td>IV</td>
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<td>VI</td>
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<td>VII</td>
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</table>

**COMMENTS**
<table>
<thead>
<tr>
<th>FEATURE TECHNICAL REQUIREMENT FLIGHT MODEL</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>2.1 FLIGHT DYNAMICS MODEL</td>
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<tr>
<td>2.1.S.a Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight supported by type-specific flight test data, including the effect of change in aeroplane attitude, sideslip, thrust, drag, altitude, temperature, gross mass, moments of inertia, centre of gravity location and configuration to support the approved use.</td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td>2.1.S.b Aerodynamic modelling, that includes, for aeroplanes issued an original type certificate after 30 June 1980, Mach effect, normal and reverse dynamic thrust effect on control surfaces, aeroelastic effect and representations of non-linearities due to side-slip based on aeroplane flight test data provided by the aeroplane manufacturer.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>SOC required. Mach effect, aeroelastic representations and non-linearities due to side-slip are normally included in the flight simulator aerodynamic model. The SOC should address each of these items. Separate tests for thrust effects and an SOC are required.</td>
</tr>
<tr>
<td>2.1.S.c Aerodynamic modelling to include ground effect derived from type-specific flight test data. For example: round-out, flare and touchdown. This requires data on lift, drag, pitching moment, trim and power in ground effect.</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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<td></td>
<td>SOC required. See Appendix B, paragraph 3.3 and test 2.f for further information on ground effect.</td>
</tr>
<tr>
<td>2.1.S.d Aerodynamic modelling for the effects of reverse thrust on directional control.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Tests required. See Appendix B, tests 2.e.8 and 2.e.9 (directional control).</td>
</tr>
<tr>
<td>2.1.S.e Modelling that includes the effects of icing, where appropriate, on the airframe, aerodynamics and the engine(s). Icing models should simulate the aerodynamic degradation effects of ice accretion on the aeroplane lifting surfaces including loss of lift, decrease in stall angle of attack, change in pitching moment, decrease in control effectiveness, and changes in control forces in addition to any overall increase in drag or aeroplane gross weight.</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
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<td>SOC should be provided describing the effects which provide training in the specific skills required for recognition of icing phenomena and execution of recovery. The SOC should include verification that these effects have been tested. Icing effects simulation models are only required for those aeroplanes authorized for operations in icing conditions. Icing simulation models should be developed to provide training in the specific skills required for recognition of ice accumulation and execution of the required response.</td>
</tr>
<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
<td>Type I</td>
<td>Type II</td>
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<td>COMMENTS</td>
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<tr>
<td>FLIGHT MODEL</td>
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<tr>
<td>2.1.R Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight, including the effect of change in aeroplane attitude, sideslip, thrust, drag, altitude, temperature, gross weight, moments of inertia, centre of gravity location, and configuration.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>2.1.G Modelling, aeroplane-like, not specific to class, model, type or variant. Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight and supported by aeroplane generic data, including the effect of change in aeroplane attitude, sideslip, thrust, drag, altitude, temperature, gross weight, moments of inertia, centre of gravity location, and configuration.</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>2.2 MASS PROPERTIES</td>
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<tr>
<td>2.2.S Type specific implementation of aeroplane mass properties, including mass, centre of gravity and moments of inertia as a function of payload and fuel loading. The effects of pitch attitude and of fuel slosh on the aircraft centre of gravity should be simulated.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td></td>
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<td>SOC required. SOC should include a range of tabulated target values to enable a demonstration of the mass properties model to be conducted from the instructor’s station. The SOC should include the effects of fuel slosh on centre of gravity.</td>
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<td>2.2.R N/A</td>
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<td>2.2.G N/A</td>
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</table>
### 3. REQUIREMENT — GROUND REACTION AND HANDLING CHARACTERISTICS

#### FEATURE GENERAL REQUIREMENT

<table>
<thead>
<tr>
<th>Requirement</th>
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<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.S Represents ground reaction and handling characteristics of the aeroplane during surface operations to support the approved use. Brake and tire failure dynamics (including antiskid) and decreased brake efficiency should be specific to the aircraft simulated. Stopping and directional control forces should be representative for all environmental runway conditions.</td>
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<td>✓</td>
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<tr>
<td>3.R Represents ground reaction and handling, aeroplane-like, derived from and appropriate to class.</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td>3.G Represents ground reaction, aeroplane-like, derived from and appropriate to class. Simple aeroplane like ground reactions, appropriate to the aeroplane mass and geometry.</td>
<td>✓</td>
<td>✓</td>
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</table>

#### FEATURE TECHNICAL REQUIREMENT

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<thead>
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<th>Requirement</th>
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<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Spline reaction and handling simulation to include:</td>
<td></td>
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<td>✓</td>
<td>✓</td>
<td></td>
<td>SOC required. Tests required.</td>
</tr>
<tr>
<td>(1) Ground reaction. Reaction of the aeroplane upon contact with the runway during take-off, landing and ground operations to include strut deflections, tire friction, side forces, environmental effects and other appropriate data, such as weight and speed, necessary to identify the flight condition and configuration; and</td>
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<td>✓</td>
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<tr>
<td>(2) Ground handling characteristics. Steering inputs to include crosswind, braking, thrust reversing, deceleration and turning radius.</td>
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</table>
### FEATURE TECHNICAL REQUIREMENT

#### GROUND REACTION AND HANDLING CHARACTERISTICS

<table>
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<tr>
<th>Requirement</th>
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<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>
| 3.1.R | Representative aeroplane ground handling simulation to include:  
(1) Ground reaction. Reaction of the aeroplane upon contact with the runway during take-off, landing and ground operations to include strut deflections, tire friction, side forces and other appropriate data, such as weight and speed, necessary to identify the flight condition and configuration; and  
(2) Ground handling characteristics. Steering inputs to include crosswind, braking, thrust reversing, deceleration and turning radius. | ✓ | ✓ | ✓ | ✓ | SOC required. Tests required. |
| 3.1.G | Generic ground reaction and ground handling models to enable touchdown effects to be reflected by the sound and visual systems. | ✓ | ✓ | |
| 3.2 | RUNWAY CONDITIONS |
| 3.2.S | Stopping and directional control forces for at least the following runway conditions based on aeroplane related data:  
(1) dry;  
(2) wet;  
(3) icy;  
(4) patchy wet;  
(5) patchy icy; and  
(6) wet on rubber residue in touchdown zone. | ✓ | ✓ | ✓ | ✓ | SOC required. Objective tests required for (1), (2) and (3). See Appendix B, tests 1.e (stopping). Subjective tests for (4), (5) and (6). See Appendix C. |
| 3.2.R | Stopping and directional control forces should be representative for at least the following runway conditions based on aeroplane related data:  
(1) dry; and  
(2) wet. | ✓ | ✓ | ✓ | ✓ |
| 3.2.G | Stopping and directional control forces for dry runway conditions. | ✓ | ✓ | |
## Appendix A. FSTD requirements

<table>
<thead>
<tr>
<th>FEATURE TECHNICAL REQUIREMENT GROUND REACTION AND HANDLING CHARACTERISTICS</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>3.3 BRAKE AND TIRE FAILURES</td>
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<tr>
<td>3.3.S Brake and tire failure dynamics (including anti-skid) and decreased braking efficiency due to brake temperatures.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>N/A.</td>
<td></td>
<td></td>
<td>SOC required. Subjective tests required for decreased braking efficiency due to brake temperature, if applicable.</td>
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<tr>
<td>3.3.R N/A.</td>
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<tr>
<td>3.3.G N/A.</td>
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4. REQUIREMENT — AEROPLANE SYSTEMS (ATA)

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<tr>
<td>4.S</td>
<td>Aeroplane systems should be replicated with sufficient functionality for flight crew operation to support the approved use. System functionality should enable all normal, abnormal, and emergency operating procedures to be accomplished. To include communications, navigation, caution and warning equipment corresponding to the aeroplane. Circuit breakers required for operations should be functional.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>4.R</td>
<td>Aeroplane systems should be replicated with sufficient functionality for flight crew operation to support the approved use. System functionality should enable sufficient normal and appropriate abnormal and emergency operating procedures to be accomplished.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>4.1.S</td>
<td>All aeroplane systems represented in the FSTD should simulate the specific aeroplane type system 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.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Aeroplane system operation should be predicated on, and traceable to, the system data supplied by either the aeroplane manufacturer, original equipment manufacturer or alternative approved data for the aeroplane system or component. 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.</td>
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### FEATURE TECHNICAL REQUIREMENT
#### AEROPLANE SYSTEMS (ATA)

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<tr>
<td>4.1.R</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>Aeroplane system operation should be predicated on, and traceable to, the system data supplied by either the aeroplane manufacturer, original equipment manufacturer or alternative approved data for the aeroplane system or component. 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.</td>
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<tr>
<td>4.1.G</td>
<td>N/A.</td>
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<tr>
<td>4.2 S</td>
<td>Circuit breakers should affect procedures and/or result in observable cockpit/flight deck indications should be functionally accurate.</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>4.2.R</td>
<td>Circuit breakers that affect procedures and/or result in observable cockpit/flight deck indications should be functionally accurate.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Applicable if circuit breakers fitted.</td>
</tr>
<tr>
<td>4.2.G</td>
<td>N/A.</td>
<td></td>
<td></td>
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<tr>
<td>4.3 S</td>
<td>All relevant instrument indications involved in the simulation of the aeroplane should automatically respond to control movement by a flight crew member or to atmospheric disturbance and also respond to effects resulting from icing.</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Numerical values should be presented in the appropriate units.</td>
</tr>
<tr>
<td>4.3.R</td>
<td>All relevant instrument indications involved in the class of aeroplanes simulated should automatically respond to control movement by a flight crew member or to atmospheric disturbance and also respond to effects resulting from icing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Numerical values should be presented in the appropriate units.</td>
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<td>4.3.G</td>
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<tr>
<td>4.4 COMMUNICATIONS, NAVIGATION AND CAUTION AND WARNING SYSTEMS</td>
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<tr>
<td>4.4.S Communications, navigation, and caution and warning equipment corresponding to that installed in a specific aeroplane type should operate within the tolerances prescribed for the applicable airborne equipment.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>4.4.R Communications, navigation, and caution and warning equipment corresponding to that typically installed in a representative aeroplane simulation should operate within the tolerances prescribed for the applicable airborne equipment.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>4.4.G N/A.</td>
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<tr>
<td>4.5 ANTI-ICING SYSTEMS</td>
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<tr>
<td>4.5.S Operation of anti-icing systems corresponding to those installed in the specific aeroplane type should operate with appropriate effects upon ice formation on airframe, engines and instrument sensors.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>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.</td>
</tr>
<tr>
<td>4.5.R Anti-icing systems corresponding to those typically installed in that class of aeroplanes should be operative.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>4.5.G N/A.</td>
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## 5. REQUIREMENT — FLIGHT CONTROLS AND FORCES

### FEATURE GENERAL REQUIREMENT

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<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.S</td>
<td>Control forces and control travel should correspond to that of the aeroplane to support the approved use. Control displacement should generate the same effect as the aeroplane under the same flight conditions. Control feel dynamics should replicate the aeroplane simulated.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.R</td>
<td>Aeroplane-like, derived from class, appropriate to aeroplane mass to support the approved use. Active force feedback required.</td>
<td>✓</td>
<td>PPL</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>5.R1</td>
<td>Aeroplane-like, derived from class, appropriate to aeroplane mass to support the approved use. Active force feedback not required.</td>
<td>✓</td>
<td>MPL1</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5.G</td>
<td>Aeroplane-like to support the approved use. Active force feedback not required.</td>
<td>✓</td>
<td>✓</td>
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<td>CONTROL FORCES AND TRAVEL</td>
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<td></td>
<td></td>
<td></td>
<td>Testing of position versus force is not applicable if forces are generated solely by use of aeroplane hardware in the FSTD.</td>
</tr>
<tr>
<td>5.1.S</td>
<td>Control forces, control travel and surface position should correspond to that of the type-specific aeroplane being replicated. Control travel, forces and surfaces should react in the same manner as in the aeroplane under the same flight and system conditions.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Active Force feedback required if appropriate to the aeroplane installation.</td>
<td></td>
</tr>
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<td>FLIGHT CONTROLS AND FORCES</td>
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</tr>
<tr>
<td>5.1.R Control forces, control travel and surface position should correspond to that of the aeroplane or class of aeroplanes being simulated. Control travel, forces and surfaces should react in the same manner as in the aeroplane or class of aeroplanes under the same flight and system conditions.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Active Force feedback required if appropriate to the aeroplane installation.</td>
</tr>
<tr>
<td>5.1.R1 Control forces, control travel and surface position should correspond to that of the aeroplane or class of aeroplanes being simulated. Control surfaces should react in the same manner as in the aeroplane or class of aeroplanes under the same flight and system conditions, but control travel and forces should broadly correspond to the aeroplane or class of aeroplanes simulated.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>Active Force feedback not required.</td>
</tr>
<tr>
<td>5.1.G Control forces, control travel and surface position should broadly correspond to the aeroplane or class of aeroplanes simulated.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Active Force feedback not required. Control forces produced by a passive arrangement are acceptable.</td>
</tr>
<tr>
<td>5.2 CONTROL FEEL DYNAMICS</td>
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<tr>
<td>5.2.S Control feel dynamics should replicate the aeroplane simulated.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>See Appendix B, paragraph 3.2 for a discussion of acceptable methods of validating control dynamics. Tests required. See Appendix B, tests 2.b.1 through 2.b.3 (dynamic control checks).</td>
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<tr>
<td>5.2.R,G N/A.</td>
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<tr>
<td>5.3.S Control systems should replicate aeroplane 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.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>See Appendix C for applicable testing.</td>
</tr>
<tr>
<td>5.3.R, R1 Control systems should replicate the class of aeroplanes 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.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>See Appendix C for applicable testing.</td>
</tr>
<tr>
<td>5.3.G Control systems should allow basic aeroplane operation with appropriate cockpit indications.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>See Appendix C for applicable testing.</td>
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6. REQUIREMENT — SOUND CUES

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<tr>
<td>6.R</td>
<td>Significant sounds perceptible to the flight crew during flight operations to support the approved use. Comparable engine, airframe and environmental sounds. The volume control should have an indication of sound level setting.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
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<tr>
<td>6.G</td>
<td>Significant sounds perceptible to the flight crew during flight operations to support the approved use. Comparable engine and airframe sounds.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
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<tr>
<td>6.1.R</td>
<td>Significant cockpit/flight deck sounds during normal and abnormal operations corresponding to those of the aeroplane, including engine and airframe sounds as well as those which result from pilot or instructor-induced actions.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
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<tr>
<td>6.1.G</td>
<td>Significant cockpit/flight deck sounds during normal and abnormal operations, aeroplane class-like, including engine and airframe sounds as well as those which result from pilot or instructor-induced actions.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
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<tr>
<td>6.2</td>
<td>CRASH SOUNDS</td>
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<tr>
<td>6.2.R</td>
<td>The sound of a crash when the simulated aeroplane exceeds limitations.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
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</tr>
<tr>
<td>6.2.G The sound of a crash when the simulated aeroplane exceeds limitations.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>6.3 ENVIRONMENTAL SOUNDS</td>
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<tr>
<td>6.3.R Significant environmental sounds should be coordinated with the simulated weather.</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>6.3.G Environmental sounds are not required. However, if present, they should be coordinated with the simulated weather.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>6.4 SOUND VOLUME</td>
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<tr>
<td>6.4.R The volume control should have an indication of sound level setting which meets all qualification requirements.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>The abnormal setting should consist of an annunciation on a main IOS page which is always visible to the instructor.</td>
<td></td>
</tr>
<tr>
<td>6.4.G The volume control should have an indication of sound level setting which meets all qualification requirements.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>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.</td>
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<tr>
<td>6.5 SOUND DIRECTIONALITY</td>
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<tr>
<td>6.5.R Sound should be directionally representative.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>SOC required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.5.G Sound not required to be directional.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</table>
## 7. REQUIREMENT — VISUAL DISPLAY CUE

<table>
<thead>
<tr>
<th></th>
<th>FEATURE GENERAL REQUIREMENT VISUAL DISPLAY CUE</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.S</td>
<td>Continuous field of view with infinity perspective and textured representation of all ambient conditions for each pilot, to support the approved use. Horizontal and vertical field of view to support the most demanding manoeuvres requiring a continuous view of the runway. A minimum of 200° horizontal and 40° vertical field of view.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>7.R</td>
<td>Continuous field of view with textured representation of all ambient conditions for each pilot, to support the approved use. Horizontal and vertical field of view to support the most demanding manoeuvres requiring a continuous view of the runway. A minimum of 200° horizontal and 40° vertical field of view.</td>
<td>✓ PPL</td>
<td>✓ CPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>7.G</td>
<td>A textured representation of appropriate ambient conditions, to support the approved use. Horizontal and vertical field of view to support basic instrument flying and transition to visual from straight-in instrument approaches.</td>
<td>✓ MPL1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>7.1</td>
<td>DISPLAY</td>
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<tr>
<td>7.1.1</td>
<td>DISPLAY GEOMETRY AND FIELD OF VIEW</td>
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<tr>
<td>7.1.1.S</td>
<td>Continuous, cross-cockpit, collimated visual. Display providing each pilot with a minimum 200° horizontal and 40° vertical field of view. The system should be free from optical discontinuities and artefacts that create non-realistic cues.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.a.1. An SOC is acceptable in place of this test. Note.— Where the training task includes circling approaches with the landing on the reciprocal runway, a visual field of view in excess of 200° horizontal and 40° vertical would probably be required. Until such time as this becomes feasible the current arrangements in place with individual NAA regarding approval for conducting specific circling approaches on a particular FSTD remain in place.</td>
<td></td>
</tr>
<tr>
<td>7.1.1.R</td>
<td>Continuous visual field of view providing each pilot with 200° horizontal and 40° vertical field of view.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.a.1. Collimation is not required but parallax effects should be minimized (not greater than 10° for each pilot when aligned for the point midway between the left and right seat eyepoints). The system should have the capability to align the view to the pilot flying. Note.— Larger fields of view may be required for certain training tasks. The FOV should be agreed with the NAA. Installed alignment should be confirmed in an SOC. (This would generally be results from acceptance testing).</td>
<td></td>
</tr>
<tr>
<td>7.1.1.G</td>
<td>A field of view of a minimum of 45° horizontally and 30° vertically, unless restricted by the type of aeroplane, simultaneously for each pilot. 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.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.a.1. Collimation is not required.</td>
<td></td>
</tr>
<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
<td>VISUAL CUES</td>
<td>Type I</td>
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<td>7.1.2</td>
<td>DISPLAY RESOLUTION</td>
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<tr>
<td>7.1.2.S</td>
<td>Display 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 eye point.</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<td></td>
<td>SOC required containing calculations confirming resolution. See Appendix B (visual scene quality) – Test 4.a.3.</td>
</tr>
<tr>
<td>7.1.2.R</td>
<td>Display 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 eye point.</td>
<td>✓</td>
<td>PPL CPL</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>SOC required containing calculations confirming resolution. See Appendix B (visual scene quality) – Test 4.a.3.</td>
</tr>
<tr>
<td>7.1.2.G</td>
<td>Adequate resolution to support the approved use.</td>
<td>✓</td>
<td>MPL1</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>7.1.3</td>
<td>LIGHT-POINT SIZE</td>
<td></td>
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<tr>
<td>7.1.3.S</td>
<td>Light-point size — not greater than 5 arc minutes.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>SOC required confirming test pattern represents lights used for airport lighting. See Appendix B – Test 4.a.4.</td>
</tr>
<tr>
<td>7.1.3.R</td>
<td>Light-point size — not greater than 8 arc minutes.</td>
<td>✓</td>
<td>PPL CPL</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>SOC required confirming test pattern represents lights used for airport lighting. See Appendix B – Test 4.a.4.</td>
</tr>
<tr>
<td>7.1.3.G</td>
<td>Suitable to support the approved use.</td>
<td>✓</td>
<td>MPL1</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>7.1.4</td>
<td>DISPLAY CONTRAST RATIO</td>
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<tr>
<td>7.1.4.S</td>
<td>Display Contrast ratio — not less than 5:1.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B (surface contrast ratio) – Test 4.a.5.</td>
</tr>
<tr>
<td>7.1.4.R</td>
<td>Display Contrast ratio — not less than 5:1.</td>
<td>✓</td>
<td>PPL CPL</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<td></td>
<td>See Appendix B (surface contrast ratio) – Test 4.a.5.</td>
</tr>
<tr>
<td>7.1.4.G</td>
<td>Suitable to support the approved use.</td>
<td>✓</td>
<td>MPL1</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>7.1.5</td>
<td>LIGHT-POINT CONTRAST RATIO</td>
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<tr>
<td>7.1.5.R</td>
<td>Light-point contrast ratio — not less than 10:1.</td>
<td>✓</td>
<td>PPL CPL</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
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<td>See Appendix B (light-point contrast ratio) – Test 4.a.6.</td>
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<td>VISUAL CUES</td>
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<tr>
<td>7.1.5.G</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>Suitable to support the approved use.</td>
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<td>7.1.6</td>
<td></td>
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<td>LIGHT-POINT BRIGHTNESS</td>
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<tr>
<td>7.1.6.S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>Light-point brightness – not less than 30 cd/m² (8.8 foot-lamberts).</td>
<td></td>
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<tr>
<td>7.1.6.R</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>Light-point brightness – not less than 20 cd/m² (5.8 foot-lamberts).</td>
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<tr>
<td>7.1.7</td>
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<td></td>
<td>DISPLAY BRIGHTNESS</td>
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<tr>
<td>7.1.7.S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>Display brightness should be demonstrated using a raster drawn test pattern. The surface brightness should not be less than 20 cd/m² (5.8 foot-lamberts).</td>
<td></td>
</tr>
<tr>
<td>7.1.7.R</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>Display brightness should be demonstrated using a raster drawn test pattern. The surface brightness should not be less than 14 cd/m² (4.1 foot-lamberts).</td>
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<td>7.1.8</td>
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<td></td>
<td>BLACK LEVEL AND SEQUENTIAL CONTRAST (Light valve systems only)</td>
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<tr>
<td>7.1.8.S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>The black level and sequential contrast need to be measured to determine it is sufficient for training in all times of day.</td>
<td></td>
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<tr>
<td>7.1.8.R</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>Suitable to support the approved use.</td>
<td></td>
</tr>
<tr>
<td>7.1.8.G</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>Suitable to support the approved use.</td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT VISUAL CUES</td>
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<tr>
<td>7.1.9 MOTION BLUR (Light valve systems only)</td>
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<tr>
<td>7.1.9.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.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>A test is generally only required for light valve projectors. An SOC should be provided if the test is not run, stating why. See Appendix B – Test 4.a.10.</td>
</tr>
<tr>
<td>7.1.9.R Suitable to support the approved use.</td>
<td>✓ PPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>7.1.9.G Suitable to support the approved use.</td>
<td>✓ MPL1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>7.1.10 SPECKLE TEST (Laser systems only)</td>
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<tr>
<td>7.1.10.S A test is required to determine that the speckle typical of laser-based displays is below a distracting level.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>A test is generally only required for laser projectors. An SOC should be provided if the test is not run, stating why. See Appendix B – Test 4.a.11.</td>
</tr>
<tr>
<td>7.1.10.R Suitable to support the approved use.</td>
<td>✓ PPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>7.1.10.G Suitable to support the approved use.</td>
<td>✓ MPL1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>7.2 ADDITIONAL DISPLAY SYSTEMS</td>
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<tr>
<td>7.2.1 HEAD-UP DISPLAY (where fitted)</td>
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<tr>
<td>7.2.1.S The system should be shown to perform its intended function for each operation and phase of flight. An active display (repeater) of all parameters displayed on the pilot's combiner 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 combiner.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>SOC required. See Appendix B – Test 4.b and Attachment K.</td>
</tr>
<tr>
<td>FEATURE TECHNICAL REQUIREMENT VISUAL CUES</td>
<td>Type I</td>
<td>Type II</td>
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<td>COMMENTS</td>
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<tr>
<td>7.2.1.R The system should be shown to perform its intended function for each operation and phase of flight. An active display (repeater) of all parameters displayed on the pilot's combiner 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 combiner.</td>
<td>✓ PPL CPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>SOC required. See Appendix B – Test 4.b and Attachment K. Only the one HUD can be used by the pilot flying due to alignment display issues. Alternatively the HUD may be presented as part of the visual scene.</td>
<td></td>
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<tr>
<td>7.2.1.G N/A.</td>
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<tr>
<td>7.2.2 ENHANCED FLIGHT VISION SYSTEM (EFVS) (Where fitted)</td>
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<tr>
<td>7.2.2.S The EFVS simulator hardware/software, including associated cockpit displays and annunciation, should function the same or equivalent to the EFVS system installed in the aeroplane. 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 aeroplane type). Image should be repeated on the IOS as per HUD requirement in 7.2.1.S herein. IOS weather presets should be provided for EFVS minimums.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.c and Attachment L.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2.2.R The EFVS simulator hardware/software, including associated cockpit displays and annunciation, should function the same or equivalent to the EFVS system installed in the aeroplane. 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 aeroplane type).</td>
<td>✓ PPL CPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.c and Attachment L. Only the one EFVS can be used by the pilot flying due to alignment display issues. Alternatively the EFVS may be presented as part of the visual scene.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2.2.G N/A.</td>
<td></td>
<td></td>
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### FEATURE TECHNICAL REQUIREMENT

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<tr>
<th>VISUAL CUES</th>
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<tr>
<td>7.3 VISUAL GROUND SEGMENT</td>
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<tr>
<td>7.3.S A test is required to demonstrate that the visibility is correct on final approach in CAT II conditions and the positioning of the aeroplane is correct relative to the runway.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>See Appendix B – Test 4.d.</td>
</tr>
<tr>
<td>7.3.R A test is required to demonstrate that the visibility is correct on final approach in CAT II conditions and the positioning of the aeroplane is correct relative to the runway.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
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<td>See Appendix B – Test 4.d.</td>
</tr>
<tr>
<td>7.3.G A demonstration of suitable visibility.</td>
<td>✓</td>
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- PPL
- CPL
- MPL1
### 8. REQUIREMENT — MOTION CUES

#### 8. FEATURE GENERAL REQUIREMENT

**MOTION CUES**

<table>
<thead>
<tr>
<th>8.S</th>
<th>N/A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.R</td>
<td>Pilot receives an effective and representative motion cue and stimulus, which provides the appropriate sensations of acceleration of the aeroplane’s 6 degrees of freedom (DOF). Motion cues should always provide the correct sensation, to support the approved use.</td>
</tr>
<tr>
<td>8.R1</td>
<td>Pilot receives an effective and representative motion cue and stimulus, which provides the appropriate sensations of acceleration of the aeroplane’s 6 degrees of freedom. Motion cues should always provide the correct sensation, to support the approved use. These sensations may be generated by a variety of methods which are specifically not prescribed. The sensation of motion can be less for simplified non-type specific training, the magnitude of the cues being reduced.</td>
</tr>
<tr>
<td>8.G</td>
<td>N/A.</td>
</tr>
</tbody>
</table>

#### 8. FEATURE TECHNICAL REQUIREMENT

**MOTION CUES**

<table>
<thead>
<tr>
<th>8.1</th>
<th>MOTION CUES GENERAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1.R</td>
<td>Motion cues (force) in 6 DOF, as perceived by the pilot, should be representative of the simulated aeroplane’s motion (e.g. touchdown cues should be a function of the rate of descent (R/D) of the simulated aeroplane).</td>
</tr>
</tbody>
</table>
## FEATURE TECHNICAL REQUIREMENT

<table>
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<th>MOTION CUES</th>
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<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1.R1 Motion cues (force) in 6 DOF, as perceived by the pilot, should be representative of the simulated aeroplane’s motion (e.g. touchdown cues should be a function of the R/D of the simulated aeroplane).</td>
<td>✓</td>
<td></td>
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<td></td>
<td></td>
<td>SOC required.</td>
</tr>
</tbody>
</table>

### 8.2 MOTIONFORCE CUEING

| 8.2.R | A motion system (force cueing) should produce cues at least equivalent to those of a 6 DOF platform motion system (i.e., pitch, roll, yaw, heave, sway, and surge). | ✓ | | | | | | SOC required. |

| 8.2.R1 | A motion system (force cueing) should produce cues at least equivalent to those of a 6 DOF platform motion system (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. | ✓ | | | | | | SOC required. |

### 8.3 MOTION EFFECTS

| 8.3.R | Motion effects should include characteristic motion vibrations, buffets and bumps that result from operation of the aeroplane, in so far as these mark an event or aeroplane state that can be sensed at the cockpit/flight deck. Such effects should be in at least 3 axes, x, y and z, to represent the effects as experienced in the aeroplane: See Appendix C. | | | | | | | |

8.3.R (1) Taxiing effects such as lateral and directional cues resulting from steering and braking inputs. ✓ |

8.3.R (2) Effects of runway and taxiway rumble, oleo deflections, uneven runway, runway contamination with associated anti-skid characteristics, centre line lights characteristics (such effects should be a function of groundspeed). ✓ |

8.3.R (3) Buffets on the ground due to spoiler/speedbrake extension and thrust reversal. ✓ |

8.3.R (4) Bumps associated with the landing gear. ✓ |

8.3.R (5) Buffet during extension and retraction of landing gear. ✓ |
<table>
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<tr>
<th>FEATURE TECHNICAL REQUIREMENT</th>
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<th>Type III</th>
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<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>8.3.R (6) Buffet in the air due to flap and</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>✔</td>
<td>Touchdown bumps should reflect the effects of lateral and directional cues resulting from crab or crosswind landings.</td>
</tr>
<tr>
<td>spoiler/speedbrake extension.</td>
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<tr>
<td>8.3.R (7) Buffet due to atmospheric disturbances, e.g. turbulence in three linear axes (isotropic).</td>
<td></td>
<td>✔</td>
<td></td>
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</tr>
<tr>
<td>8.3.R (8) Approach to stall buffet.</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
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<td>✔</td>
<td></td>
</tr>
<tr>
<td>8.3.R (9) Touchdown cues for main and nose gear.</td>
<td>✔</td>
<td>✔</td>
<td></td>
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</tr>
<tr>
<td>8.3.R (10) Nosewheel scuffing (if applicable).</td>
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<tr>
<td>8.3.R (11) Thrust effect with brakes set.</td>
<td></td>
<td>✔</td>
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</tr>
<tr>
<td>8.3.R (12) Mach and manoeuvre buffet.</td>
<td></td>
<td>✔</td>
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<td></td>
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</tr>
<tr>
<td>8.3.R (13) Tire failure dynamics.</td>
<td></td>
<td>✔</td>
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<tr>
<td>8.3.R (14) Engine failures, malfunctions and engine damage.</td>
<td>✔</td>
<td>✔</td>
<td></td>
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<td></td>
<td>Appropriate cues to aid recognition of failures for flight critical cases (e.g. directional and lateral cues for asymmetric engine failure).</td>
</tr>
<tr>
<td>8.3.R (15) Tail and pod strike.</td>
<td></td>
<td>✔</td>
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<tr>
<td>8.3.R (16) Other significant vibrations, buffets and bumps that are not mentioned above (e.g. RAT), or checklist items such as motion effects due to pre-flight flight control inputs.</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>8.3.R1 Motion effects should include characteristic motion vibrations, buffets and bumps that result from operation of the aeroplane, in so far as these mark an event or aeroplane state that can be sensed at the cockpit/flight deck. Such effects should be in 3 axes, x, y and z, to represent the effects as experienced in the aeroplane:</td>
<td>✔</td>
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<tr>
<td>8.3.R1 (1) Taxiing effects such as lateral and directional cues resulting from steering and braking inputs.</td>
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<td>8.3.R1 (2) Effects of runway and taxiway rumble, oleo deflections, uneven runway, runway contamination with associated anti-skid characteristics, centre line lights characteristics (such effects should be a function of groundspeed).</td>
<td>✔</td>
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<tr>
<td>8.3.R1 (3) Buffets on the ground due to spoiler/speedbrake extension and thrust reversal.</td>
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<tr>
<td>8.3.R1 (4) Bumps associated with the landing gear.</td>
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<tr>
<td>8.3.R1 (5) Buffet during extension and retraction of landing gear.</td>
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<td>8.3.R1 (6) Buffet in the air due to flap and spoiler/speedbrake extension.</td>
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<tr>
<td>8.3.R1 (8) Approach to stall buffet.</td>
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<td>8.3.R1 (9) Touchdown cues for main and nose gear.</td>
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<td>Touchdown bumps should reflect the effects of lateral and directional cues resulting from crab or crosswind landings.</td>
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<tr>
<td>8.3.R1 (10) Nosewheel scuffing (if applicable).</td>
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<tr>
<td>8.3.R1 (11) Thrust effect with brakes set.</td>
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<td>8.3.R1 (12) Mach and manoeuvre buffet.</td>
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<td>8.3.R1 (13) Tire failure dynamics.</td>
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<td>8.3.R1 (14) Engine failures, malfunctions and engine damage.</td>
<td>✔</td>
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<td>✔️</td>
<td></td>
<td>Appropriate cues to aid recognition of failures for flight critical cases (e.g. directional and lateral cues for asymmetric engine failure).</td>
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<tr>
<td>8.3.R1 (15) Tail and pod strike.</td>
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<td>8.3.R1 (16) Other significant vibrations, buffets and bumps that are not mentioned above (e.g. RAT), or checklist items such as motion effects due to pre-flight flight control inputs.</td>
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<td>8.4</td>
<td>MOTION VIBRATIONS</td>
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<tr>
<td>8.4.R</td>
<td>Motion vibrations tests are required and should include recorded results that allow the comparison of relative amplitudes versus frequency (relevant frequencies up to at least 20 Hz). Characteristic motion vibrations that result from operation of the aeroplane should be present, in so far as vibration marks an event or aeroplane state that can be sensed at the cockpit/flight deck. The FSTD should be programmed and instrumented in such a manner that the characteristic vibration modes can be measured and compared to aeroplane data.</td>
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<tr>
<td>See Appendix B – Test 3.f.</td>
<td>An SOC is required.</td>
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<tr>
<td>8.4.R (1)</td>
<td>Thrust effects with brakes set.</td>
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<tr>
<td>8.4.R (2)</td>
<td>Landing gear extended buffet.</td>
<td>✓</td>
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<tr>
<td>8.4.R (3)</td>
<td>Flaps extended buffet.</td>
<td>✓</td>
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<tr>
<td>8.4.R (4)</td>
<td>Speedbrake deployed buffet.</td>
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<tr>
<td>8.4.R (5)</td>
<td>Approach to stall buffet.</td>
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<tr>
<td>8.4.R (6)</td>
<td>High speed or Mach buffet.</td>
<td>✓</td>
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<tr>
<td>8.4.R (7)</td>
<td>In-flight vibrations.</td>
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<tr>
<td>8.4.R1</td>
<td>Motion vibrations tests are required and should include recorded results that allow the comparison of relative amplitudes versus frequency (relevant frequencies up to at least 20 Hz). Characteristic motion vibrations that result from operation of the aeroplane should be present, in so far as the vibration marks an event or aeroplane state that can be sensed at the cockpit/flight deck. The FSTD should be programmed and instrumented in such a manner that the characteristic vibration modes can be measured.</td>
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</tr>
<tr>
<td>See Appendix B – Test 3.f.</td>
<td>An SOC is required.</td>
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<tr>
<td>8.4.R1 (1)</td>
<td>Thrust effects with brakes set.</td>
<td>✓</td>
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<tr>
<td>8.4.R1 (2)</td>
<td>Landing gear extended buffet.</td>
<td>✓</td>
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<tr>
<td>8.4.R1 (3)</td>
<td>Flaps extended buffet.</td>
<td>✓</td>
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<tr>
<td>8.4.R1 (4) Speedbrake deployed buffet.</td>
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<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>8.4.R1 (5) Approach to stall buffet.</td>
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<td></td>
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<td>✓</td>
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<tr>
<td>8.4.R1 (6) High speed or Mach buffet.</td>
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<td></td>
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<td>✓</td>
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<tr>
<td>8.4.R1 (7) In-flight vibrations.</td>
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<td>✓</td>
<td>✓</td>
<td>Propeller-driven aeroplanes only.</td>
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9. REQUIREMENT — ENVIRONMENT — ATC

<table>
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<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.S</td>
<td>Automated dynamic environment in the terminal area, including ATC responses to ownship voice transmissions and appropriate ATC initiated transmissions to support the approved use. Content and intensity of ownship and othership messages specific to airport context and frequency, in English (as per ICAO Doc 4444, PANS-ATM — Air Traffic Management). Randomised messages to ownship and othership messages specific to airport. Correlation with visual ground, landing and departing traffic, including terminal area simulation of airports appropriate to the training programme.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓*</td>
<td>✓* — Not required for Re (T). Recognising 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. Primary efforts by industry should be aimed at the MPL3, MPL4 and first TR needs. 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.</td>
<td></td>
</tr>
<tr>
<td>9.R</td>
<td>Flight phase and content specific ATC messages in the terminal area, including appropriate responses to ownship voice transmissions to support the approved use. Context and intensity of ownship and othership messages in English (as per ICAO Doc 4444, PANS-ATM — Air Traffic Management). Randomised messages to ownship and background messages representative of ATC control.</td>
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<td>9.G</td>
<td>Flight phase and content specific ATC messages, including responses to ownship voice transmissions in appropriate flight phases, to support the approved use. Content of ownship messages in English (as per ICAO Doc 4444, PANS ATM — Air Traffic Management). Messages to ownship typical of ATC control. Can be achieved by the instructor providing the ATC simulation.</td>
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<td>9.</td>
<td>FEATURE GENERAL REQUIREMENT ENVIRONMENT — ATC</td>
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<td>9.N</td>
<td>ATC not required.</td>
<td>✓</td>
<td>✓</td>
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<td></td>
<td></td>
<td>✓</td>
<td>Re</td>
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<td>9.1</td>
<td>AUTOMATED WEATHER REPORTING</td>
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<td></td>
<td>Automated weather reporting.</td>
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<tr>
<td>9.1.S</td>
<td>Multiple station automated weather reporting.</td>
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<td>✓</td>
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* - Not required for Re (T).

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 with part-time or no towers should be considered where relevant to the operation.

The system should have the capability of generating different automated weather reporting messages providing weather conditions and different other predefined conditions at all airports in range allowing flight crews to simultaneously listen in to concurrent automated weather reporting messages from different airports.

The instructor should have the ability to override each single value and each predefined message from the instructor station.

✓* - Not required for Re (T).
<table>
<thead>
<tr>
<th>9.</th>
<th>FEATURE GENERAL REQUIREMENT</th>
<th>TYPE I</th>
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<th>TYPE VI</th>
<th>TYPE VII</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>9.1.R</td>
<td>Single station automated weather reporting.</td>
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<td>At least one automated weather reporting message is required for all airports in range. The message(s) should consist of the actual weather conditions set in the FSTD including reference airport, 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.</td>
</tr>
<tr>
<td>9.1.G</td>
<td>Single station automated weather reporting.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>At least one automated weather-reporting message is required for all airports in range. The message(s) should consist of the actual weather conditions set in the FSTD including reference airport, 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.</td>
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</table>

**9.2 BACKGROUND CHATTER**

9.2.1 S,R,G (ctd next page) 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;

<table>
<thead>
<tr>
<th>9.2.1 S,R,G (ctd next page)</th>
<th>Background chatter (party line). In general all background chatter should meet the following criteria:</th>
<th>✓</th>
<th>✓</th>
<th>✓</th>
<th>✓</th>
<th>✓*</th>
<th>✓*</th>
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<tr>
<td>1. communications should make sense within the context of the simulation environment and should not contain obviously erroneous information;</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓*</td>
<td>✓*</td>
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<td>2. only messages relevant to the purpose of a given frequency should be heard on said frequency;</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓*</td>
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</table>

*Party line communications simulate background chatter heard on the flight deck e.g. aeroplane-to-aeroplane, aeroplane-to-ground, or ground-to-ground communications other than ownship.

* - Not required for Re (T).
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<td>ENVIRONMENT — ATC</td>
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<td>3.</td>
<td>simulated communications on a given frequency should not step over one another or over communications from the simulator crew; and</td>
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<td>4.</td>
<td>reasonable pauses should be provided between communication exchanges to allow the simulator crew access to the frequency when required.</td>
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<tr>
<td>9.2.2 S</td>
<td>Content-defined – Location-specific and content-specific messages fully correlated to the visually simulated traffic.</td>
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<td>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 3 specific terminal areas. The 3 specific terminal areas should be part of the approved training programme. ✓* - Not required for Re (T).</td>
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<tr>
<td>9.2.2 R</td>
<td>Context-defined – Generic messages common to all airports correlated to visually simulated traffic.</td>
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<td>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.</td>
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<td>9.2.2 G</td>
<td>Context-generic – Generic messages with no correlation.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>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.</td>
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<td>9.3</td>
<td>ATC SIMULATION - INTERACTION WITH SIMULATOR</td>
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<td>Messages received related to ownship position, operational situation and environmental conditions reflecting visual settings and TCAS scenario if applicable.</td>
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<tr>
<td>9.3.S.R (ctd next page)</td>
<td>Simulation Parameters The ATC communication simulation system together with aeroplane 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;</td>
<td>✓</td>
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<td>The system should include a minimum of 3 specific terminal areas. The 3 specific terminal areas should be part of the approved training programme. Including visual, when applicable. ✓* - Not required for Re (T).</td>
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<td>Active runways;</td>
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<td>Runway condition: contamination and depth of</td>
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<td>Braking action;</td>
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<td>13</td>
<td>Position, track, heading and height of own</td>
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<td>14</td>
<td>Subject aeroplane call sign.</td>
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<td>9.4</td>
<td>ATC SIMULATION - INTERACTION WITH INSTRUCTOR</td>
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<td>9.4.S.R</td>
<td>The instructor should be able to interact with the</td>
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<td>scenario by injecting messages to the ownship</td>
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<td>aeroplane. When applicable, these messages</td>
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<td>should be grouped by phase of flight or category as</td>
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<td>1. Gate:</td>
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<td>a. Dispatch;</td>
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<td>b. Maintenance;</td>
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<td>c. Departure ATIS;</td>
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<td>d. Route clearance;</td>
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<td>e. Pushback;</td>
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<td>f. Other routine ATC / company communication;</td>
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<td>3. Taxi;</td>
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<td>4. Holding position;</td>
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<td>5. Take-off;</td>
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<td>6. After take-off;</td>
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<td>7. Climb;</td>
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<td>8. En-route;</td>
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<td>9. Descent;</td>
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<td>10. Arrival ATIS;</td>
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<td>11. Hold;</td>
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<td>12. Approach;</td>
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<td>13. Landing;</td>
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<td>14. Emergency;</td>
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<td>15. Other communication; and</td>
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![Regarding 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 crews under training, testing or checking. ✓∗ - Not required for Re (T).]
<table>
<thead>
<tr>
<th>9.</th>
<th>FEATURE GENERAL REQUIREMENT ENVIRONMENT — ATC</th>
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<tr>
<td>9.5</td>
<td>ATC MESSAGE TRIGGERING</td>
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<td></td>
<td>The instructor should be able to trigger messages manually or automatically.</td>
<td>✔</td>
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<td>✔*</td>
<td>- Not required for Re (T).</td>
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<tr>
<td>9.5.1</td>
<td>Manual (basic).</td>
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<td>✔</td>
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<td>- Not required for Re (T).</td>
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<td>9.5.2</td>
<td>Automatic (enhanced).</td>
<td>✔</td>
<td>✔*</td>
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<td>✔*</td>
<td>- Not required for Re (T).</td>
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<td>9.6</td>
<td>PHRASEOLOGY</td>
<td>✔</td>
<td>✔*</td>
<td>✔</td>
<td>✔*</td>
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<td>- Not required for Re (T).</td>
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<tr>
<td>9.6.1</td>
<td>Phraseology and voice characteristics</td>
<td>✔</td>
<td>✔*</td>
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<td>9.7 FLIGHT PHASE SPECIFIC</td>
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<td>ATC FREQUENCY RECOGNITION</td>
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<td>9.7.1 S/R/G</td>
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<td></td>
<td>Communications should be</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓*</td>
<td>Flight phase specific ATC frequency recognition, a requirement for all levels of ATC simulation, means that all communication received by the pilot should be appropriate to the radio frequencies set in the cockpit. ✓* - Not required for Re (T).</td>
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<td></td>
<td>appropriate to the radio</td>
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<td>1) single-frequency</td>
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<td></td>
<td>9.7.1.2 S/R/G</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓*</td>
<td></td>
<td>Example: The pilot listening to ATIS on VHF 1 while the co-pilot waits for clearance delivery on VHF 2. ✓* - Not required for Re (T).</td>
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<td>2) multiple-frequency</td>
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<td></td>
<td>9.7.2 S/R/G</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓*</td>
<td></td>
<td>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. ✓* - Not required for Re (T).</td>
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<td>The simulated environment</td>
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<td>to company or ATC radio</td>
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<td>frequency changes.</td>
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<td>9.8</td>
<td>INSTRUCTOR CONTROL OVER</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓*</td>
<td></td>
<td>Examples of instructor control of other traffic:</td>
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<td></td>
<td>OTHER TRAFFIC</td>
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<td></td>
<td>1. Priority for ownship for take-off, landing and ground manoeuvres with respect to other traffic;</td>
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<td></td>
<td>9.8.1 S/R/G</td>
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<td>2. Another aeroplane in the scenario to have an emergency or to obstruct ownship aeroplane;</td>
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<td></td>
<td>Instructor control over</td>
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<td>3. Levels of traffic activity in the scenario; and</td>
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<td></td>
<td>other traffic.</td>
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<td>4. Restrictions on speed for an approaching aeroplane. ✓* - Not required for Re (T).</td>
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<td></td>
<td>Instructor should have the</td>
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<td>ability to control other</td>
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<td>traffic.</td>
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<td>9.8.2 S,R</td>
<td>Correlation.</td>
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<td>Air traffic control communications should be consistent with other dynamic ground and air traffic movements, including those influenced by traffic conflicts and subject aeroplane priority issues. Traffic information displayed by both visual and onboard systems should be consistent with TCAS. ✓* - Not required for Re (T).</td>
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<tr>
<td></td>
<td>Communications should be consistent with other ground and air traffic representations in the simulation and aeroplane systems (TCAS).</td>
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<tr>
<td>9.8.3 S,R</td>
<td>Traffic flow.</td>
<td></td>
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<td></td>
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<td>✓</td>
<td>✓*</td>
<td>Examples of appropriate traffic flows for a major airport: Light: 1 to 15 take-offs and/or landings per hour or less than 20 total airport movements per hour. Medium: 16 to 50 take-offs and/or landings per hour or 70 total movements per hour. Heavy: 51 or more take-offs and/or landings per hour or greater than 100 total movements per hour. ✓* - Not required for Re (T).</td>
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<td></td>
<td>Unless otherwise selected by the instructor, airport traffic flow should be representative of flow density for the time of day at the modelled airport.</td>
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<td>Representative traffic separation times should be respected.</td>
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<td>9.9</td>
<td>DATALINK COMMUNICATIONS</td>
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10. REQUIREMENT — ENVIRONMENT — NAVIGATION

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<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.S</td>
<td>Navigational data with the corresponding approach facilities to support the approved use. Navigation aids should be usable within range or line-of-sight without restriction, as applicable to the geographic area.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>N/A.</td>
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<tr>
<td>10.R</td>
<td>N/A.</td>
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<tr>
<td>10.G</td>
<td>N/A.</td>
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<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.S</td>
<td>Navigation database sufficient to support simulated aeroplane systems for real world operations.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>MINIMUM AIRPORT REQUIREMENT</td>
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<tr>
<td>10.2.S</td>
<td>Complete navigation database for at least 3 airports with corresponding precision and non-precision approach procedures, including regular updates.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>N/A.</td>
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<tr>
<td>10.2.R</td>
<td>N/A.</td>
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<td>10.2.G</td>
<td>N/A.</td>
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<td>10.3</td>
<td>INSTRUCTOR CONTROLS</td>
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<tr>
<td>10.3.S</td>
<td>Instructor controls of internal and external navigational aids.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>10.4 ARRIVAL / DEPARTURE FEATURES</td>
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<tr>
<td>10.4.S Navigational data with all the corresponding standard arrival and departure procedures.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>10.4.R N/A.</td>
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<td>10.4.G N/A.</td>
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<td>10.5 NAVIGATION AIDS RANGE</td>
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<tr>
<td>10.5.S Navigation aids should be usable within range or line-of-sight without restriction, as applicable to the geographic area.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Replication of the geographic environment with its specific limitations.</td>
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<tr>
<td>10.5.R N/A.</td>
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<td>10.5.G N/A.</td>
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### 11. REQUIREMENT — ENVIRONMENT — ATMOSPHERE AND WEATHER

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<tr>
<td>11.R</td>
<td>Fully integrated dynamic environment simulation including a representative atmosphere with weather effects to support the approved use. The environment should be synchronised with appropriate aeroplane and simulation features to provide integrity. Environment simulation should include thunderstorms, wind shear, turbulence, microbursts and appropriate types of precipitation.</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>11.G</td>
<td>Basic atmospheric model, pressure, temperature, visibility, cloud base and winds to support the approved use. The environment should be synchronised with appropriate aeroplane and simulation features to provide integrity.</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td>11.1.S</td>
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<tr>
<td>11.1.R,G</td>
<td>Simulation of the standard atmosphere including instructor control over key parameters.</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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Appendix A. Flight Simulation Training Device Criteria

II-App A-45
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<td><strong>ENVIRONMENT – ATMOSPHERE AND WEATHER</strong></td>
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| 11.2 WIND SHEAR |       |         |          |         |       |         |         |          |
| 11.2.S N/A. |       |         |          |         |       |         |         |          |
| 11.2.R The FSTD should employ wind shear models that provide training for recognition and necessary corrective pilot actions for the following critical phases of flight: | ✓     | ✓       | ✓       |         |       |         |         | Refer to Appendix B – Test 2.g. The QTG should reference the FAA Wind Shear Training Aid or present alternate aeroplane-related data, including the implementation method(s) used. If the alternate method is selected, wind models from the Royal Aeroplane Establishment (RAE) Wind Shear Training, the Joint Airport Weather Studies (JAWS) Project and other recognized sources may be implemented, but should be supported and properly referenced in the QTG. |
| 11.2.G The FSTD should employ wind shear models that provide training for recognition of wind shear phenomena. | ✓     | ✓       | ✓       |         |       |         |         | A subjective test is required. See Appendix C. |

| 11.3 WEATHER EFFECTS |       |         |          |         |       |         |         |          |
| 11.3.S N/A. |       |         |          |         |       |         |         |          |
| 11.3.R 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. |
| 11.3.R The following weather effects as observed on the visual system should be simulated and respective instructor controls provided. | ✓     | ✓       | ✓       | ✓       |       |         |         | Objective test required. Refer to Appendix B – Test 4.d. |

1. Multiple cloud layers with adjustable bases, tops, sky coverage and scud effect.
2. Storm cells activation and/or deactivation.
3. Visibility and runway visual range (RVR), including fog and patchy fog effect.
4. Effects on ownship external lighting.
5. Effects on airport external lighting (including variable intensity and fog effects).
6. Surface contaminants (including wind blowing effect).
7. Variable precipitation effects (rain, hail, snow).
8. In-cloud airspeed effect.
### FEATURE TECHNICAL REQUIREMENT
#### ENVIRONMENT – ATMOSPHERE AND WEATHER

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<tr>
<th>Type</th>
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<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
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<tbody>
<tr>
<td>(9)</td>
<td>Gradual visibility changes entering and breaking out of cloud.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>A subjective test is required. See Appendix C.</td>
</tr>
<tr>
<td>11.3 G</td>
<td>The following weather effects as observed on the visual system should be simulated and respective instructor controls provided.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>A subjective test is required. See Appendix C.</td>
</tr>
<tr>
<td>(1)</td>
<td>Visibility.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>A subjective test is required. See Appendix C.</td>
</tr>
<tr>
<td>11.4</td>
<td>INSTRUCTOR CONTROLS</td>
<td></td>
<td></td>
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<tr>
<td>11.4.S</td>
<td>N/A.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>11.4.R,G</td>
<td>The following features should be simulated with appropriate instructor controls provided:</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(1)</td>
<td>surface wind speed, direction and gusts;</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(2)</td>
<td>intermediate and high altitude wind speed and direction;</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(3)</td>
<td>thunderstorms and microbursts; and</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>(4)</td>
<td>turbulence.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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### 12. REQUIREMENT – ENVIRONMENT – AIRPORTS AND TERRAIN

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<tr>
<td>12.S</td>
<td>N/A.</td>
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<tr>
<td>12.R</td>
<td>Specific airport models with topographical features to support the approved use. Correct terrain modelling, runway orientation, markings, lighting, dimensions and taxiways. Visual terrain and EGPWS databases should be matched to support training to avoid CFIT accidents. Where the device is required to perform low visibility operations, at least one airport scene with functionality to support the required approval type, e.g. low visibility taxi route with marker boards, stop bars, runway guard lights plus the required approach and runway lighting.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Note.— The requirements should be read in conjunction with Appendix C, paragraph 12 to fully understand the details to be provided.</td>
<td></td>
</tr>
<tr>
<td>12.R(S)</td>
<td>Specific airport models with topographical features to support the approved use. Correct terrain modelling, runway orientation, markings, lighting, dimensions and taxiways. Visual terrain and EGPWS databases should be matched to support training to avoid CFIT accidents. For specific VFR cross-country training the capability to replicate ground visual references and topographical features sufficient to support VFR navigation according to appropriate charts — minimum standard 1:500 000 scale mapping.</td>
<td>✓</td>
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<tr>
<td>12.G</td>
<td>Generic airport models with topographical features to support the approved use. Correct terrain modelling, runway orientation, markings, lighting, dimensions and taxiways.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Note.— The requirements should be read in conjunction with Appendix C, paragraph 12 to fully understand the details to be provided.</td>
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### FEATURE GENERAL REQUIREMENT

**ENVIRONMENT – AIRPORTS AND TERRAIN**

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<td>12.G(S)</td>
<td>Generic airport models with topographical features to support the approved use.</td>
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</tr>
<tr>
<td></td>
<td>Correct terrain modelling, runway orientation, markings, lighting, dimensions and taxiways.</td>
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<tr>
<td></td>
<td>For specific VFR cross-country training the capability to replicate ground visual references and topographical features sufficient to support VFR navigation according to appropriate charts — minimum standard 1:500 000 scale mapping.</td>
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<td>COMMENTS</td>
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### FEATURE TECHNICAL REQUIREMENT

**ENVIRONMENT – AIRPORTS AND TERRAIN**

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<tr>
<td>12.1</td>
<td>VISUAL CUES</td>
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<tr>
<td>12.1.1R(S) G(S)</td>
<td>Visual cues to assess sink rate and depth perception during take-off and landing should be provided.</td>
<td>✓</td>
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<tr>
<td></td>
<td>This should include:</td>
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<tr>
<td></td>
<td>(1) surface on runways, taxiways, and ramps;</td>
<td></td>
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<tr>
<td></td>
<td>(2) terrain features; and</td>
<td></td>
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<tr>
<td></td>
<td>(3) highly detailed and accurate surface depiction of the terrain surface within an area sufficient to achieve cross-country flying under VFR conditions.</td>
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<tr>
<td>COMMENTS</td>
<td>PPL CPL</td>
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<tr>
<td>12.1.1R Visual cues to assess sink rate and depth perception during take-off and landing should be provided. This should include: (1) surface on runways, taxiways, and ramps; (2) terrain features; and (3) highly detailed and accurate surface depiction of the terrain surface within an approximate area from 400 m (1/4 sm) before the runway approach end to 400 m (1/4 sm) beyond the runway departure end with a total width of approximately 400 m (1/4 sm) including the width of the runway.</td>
<td>✓ PPL</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>12.1.1G Visual cues to assess sink rate and depth perception during take-off and landing should be provided. This should include: (1) surface on runways, taxiways, and ramps; and (2) terrain features.</td>
<td>✓ CPL</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>12.2 VISUAL EFFECTS</td>
<td></td>
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</tbody>
</table>
| 12.2.1R The system should provide visual effects for: (1) light poles; (2) raised edge lights as appropriate; and (3) glow associated with approach lights in low visibility before physical lights are seen. | ✓ PPL | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Note.— For Type I, PPL, “(3) glow associated with approach lights in low visibility before physical lights are seen”, is not required.
### FEATURE TECHNICAL REQUIREMENT

#### ENVIRONMENT – AIRPORTS AND TERRAIN

<table>
<thead>
<tr>
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<th>TYPE VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.3 ENVIRONMENT ATTITUDE</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Visual attitude versus FSTD attitude is a comparison of pitch and roll of the horizon as displayed in the visual scene compared to the display on the attitude indicator. Required for initial qualification only (SOC acceptable).</td>
<td></td>
</tr>
<tr>
<td>12.3.1S,R,G The FSTD should provide for accurate portrayal of the visual environment relating to the FSTD attitude.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.4 AIRPORT SCENES</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.4.1a The system should include at least 3 designated real-world airports available in daylight, twilight (dusk or dawn) and night illumination states.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>The designated real-world airports should be part of the approved training programme.</td>
<td></td>
</tr>
<tr>
<td>12.4.1b The system should include at least 1 designated real-world airport available in daylight, twilight (dusk or dawn) and night illumination states.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>The designated real-world airport(s) should be part of the approved training programme.</td>
<td></td>
</tr>
<tr>
<td>12.4.1g The system should include a generic airport available in daylight, twilight (dusk or dawn) and night illumination states.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.4.2.1S,R,G Daylight Capability.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>SOC required for system capability. System objective tests are required. See Appendix B (visual scene quality) — Test 4.a. Scene content tests are also required. See Appendix C.</td>
<td></td>
</tr>
<tr>
<td>12.4.2.2S,R,G The system should provide full-colour presentations and sufficient surfaces with appropriate textural cues to successfully accomplish a visual approach, landing and airport movement (taxi).</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.4.2.3R Surface shading effects should be consistent with simulated sun position.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>This does not imply continuous time of day.</td>
<td></td>
</tr>
<tr>
<td>12.4.2.4R Total scene content comparable in detail to that produced by 10 000 visible textured surfaces and 6 000 visible lights should be provided.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</table>

**PPL**

**CPL**

**MPL1**
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<tr>
<td>ENVIRONMENT – AIRPORTS AND TERRAIN</td>
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<tr>
<td>12.4.2.4G Total scene content should be sufficient to identify the airport and represent the surrounding terrain.</td>
<td>✓ CPL</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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<td>COMMENTS</td>
</tr>
<tr>
<td>12.4.2.5R The system should have sufficient capacity to display 16 simultaneously moving objects.</td>
<td>✓ PPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.4.3.1S, R Twilight (dusk) capability.</td>
<td>✓ PPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.4.3.2S, R The system should provide twilight (or dusk) visual scenes with full colour presentations of reduced ambient intensity and typical terrain characteristics such as fields, roads and bodies of water and surfaces illuminated by representative ownship lighting (e.g. landing lights) sufficient to successfully accomplish visual approach, landing and airport movement (taxi).</td>
<td>✓ PPL CPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.4.3.3R Total scene content comparable in detail to that produced by 10 000 visible textured surfaces and 15 000 visible lights should be provided.</td>
<td>✓ PPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.4.3.3R Scenes should include self-illuminated objects such as road networks, ramp lighting and airport signage, to conduct a visual approach, landing and airport movement (taxi).</td>
<td>✓ PPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>12.4.3.4S, R The system should include a definable horizon.</td>
<td>✓ PPL CPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>If provided, directional horizon lighting should have correct orientation and be consistent with surface shading effects.</td>
<td></td>
</tr>
<tr>
<td>12.4.3.6R The system should have sufficient capacity to display 16 simultaneously moving objects.</td>
<td>✓ PPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>12.4.4S,R Night capability.</td>
<td>✓ PPL CPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>12.4.4.1S, R The system should provide at night all features applicable to the twilight scene, as defined above, with the addition of the need to portray reduced ambient intensity that removes ground cues that are not self-illuminating or illuminated by aeroplane lights (e.g. landing lights).</td>
<td>✓ PPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>12.5 AIRPORT CLUTTER</td>
<td>✓</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>12.5.1R Airport models should include representative static and dynamic clutter such as gates, aeroplanes, and ground handling equipment.</td>
<td>✓</td>
<td>PPL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Clutter need not be dynamic unless required (e.g. ATC correlation).</td>
<td></td>
</tr>
<tr>
<td>12.6 DATABASE CURRENCY</td>
<td>✓</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
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</tr>
<tr>
<td>12.6.1R The specific airports used in the system should be maintained current with the state of the corresponding real-world airports as identified in the airport charts.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Selection of the airport 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. 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 airport buildings, or surrounding terrain; etc., but need not include minor buildings or other less important airport features not represented on the airport charts.</td>
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<tr>
<td>12.7 VISUAL SYSTEM FOR REDUCED FOV</td>
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<tr>
<td>12.7.1G The system should provide a visual scene with sufficient scene content to allow a pilot to successfully accomplish a visual landing. Scenes should include a definable horizon and typical terrain characteristics such as fields, roads and bodies of water and surfaces illuminated by aeroplane landing lights.</td>
<td>✓</td>
<td>CPL</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Airports model may be generic (no specific topographical features required).</td>
<td></td>
</tr>
<tr>
<td>12.7.2G Total scene content comparable in detail to that produced by 3 500 visible textured surfaces and 5 000 visible lights should be provided.</td>
<td>✓</td>
<td>CPL</td>
<td>✓</td>
<td></td>
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</tr>
</tbody>
</table>

Applies only to Type I FSTD when used to support MPL1 training, and to Type II FSTD when used to support IR training, both applications allowing the use of a reduced FOV visual system.
<table>
<thead>
<tr>
<th>FEATURE TECHNICAL REQUIREMENT ENVIRONMENT – AIRPORTS AND TERRAIN</th>
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<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
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<th>Type VII</th>
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<tbody>
<tr>
<td>12.8 VFR TRAINING</td>
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<tr>
<td>12.8.1S The system, when used for VFR training, should include a database area that can support a 300 nautical miles triangular flight incorporating three airports. Within the defined area the system should replicate ground visual references and topographical features sufficient to support VFR navigation according to appropriate charts.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Applies only to Type I FSTD when used for VFR operations to support CPL and PPL training. Correlation should be with 1:500 000 scale VFR Navigation Charts at a minimum, or larger scales (e.g. 1:250 000) if applicable to the area.</td>
</tr>
<tr>
<td>12.9 LOW VISIBILITY TRAINING</td>
<td></td>
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</tr>
<tr>
<td>12.9.1R The system should include at least one airport scene with functionality to support the required approval type, e.g. low visibility taxi route with marker boards, stop bars, runway guard lights plus the required approach and runway lighting.</td>
<td>✓</td>
<td>✓</td>
<td></td>
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## 13. REQUIREMENT — MISCELLANEOUS

### FEATURE GENERAL REQUIREMENT

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<tr>
<td>13.S</td>
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<td>13.G</td>
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### FEATURE TECHNICAL REQUIREMENT

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<th>COMMENTS</th>
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<tbody>
<tr>
<td>13.1</td>
<td>INSTRUCTOR OPERATING STATION</td>
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<td></td>
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</table>

**13.1S** The instructor 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.

**13.1R** The instructor station should provide an adequate view of the pilots’ panels and forward windows. ✓ ✓ ✓ ✓

<table>
<thead>
<tr>
<th>13</th>
<th>MISCELLANEOUS</th>
<th>Type I</th>
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<th>Type III</th>
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<tbody>
<tr>
<td>13.2</td>
<td>INSTRUCTOR CONTROLS</td>
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</tbody>
</table>

**13.2 S,R,G** Instructor controls should be provided for all required system variables, freezes, resets and for insertion of malfunctions to simulate abnormal or emergency conditions. The effects of these malfunctions should be sufficient to correctly exercise the procedures in relevant operating manuals. ✓ ✓ ✓ ✓ ✓ ✓ ✓

<table>
<thead>
<tr>
<th>13</th>
<th>MISCELLANEOUS</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
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<tr>
<td>13.3</td>
<td>SELF–DIAGNOSTIC TESTING</td>
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</tr>
</tbody>
</table>

**13.3S** 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.
<table>
<thead>
<tr>
<th></th>
<th>FEATURE TECHNICAL REQUIREMENT</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>COMMENTS</th>
</tr>
</thead>
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<tr>
<td>13</td>
<td>COMPUTER CAPACITY</td>
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<tr>
<td>13.4</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>13.5</td>
<td>AUTOMATIC TESTING FACILITIES</td>
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<td></td>
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</tr>
<tr>
<td>13.5S</td>
<td></td>
<td></td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>13.5R,G</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>13.6</td>
<td>UPDATES TO FSTD HARDWARE AND SOFTWARE</td>
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<tr>
<td>13.6S,R</td>
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<td></td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>13.7</td>
<td>DAILY PRE-FLIGHT DOCUMENTATION</td>
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<td>13.7S,R,G</td>
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<td>Type II</td>
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</tr>
<tr>
<td>13.8</td>
<td>SYSTEM INTEGRATION</td>
<td></td>
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</tr>
</tbody>
</table>
| 13.8 | System Integration. | Relative response of the visual system, cockpit/flight deck 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 100 milliseconds (ms). Motion onset should also occur within the system dynamic response limit of 100 ms. 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. 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. |          |         |         | ✓      | ✓      |          | Test required. See Appendix B, Transport delay – Test 6.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 test methodology and also latency. |
| 13.8S | Transport delay: | | |         |          |         |       |         |          | 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 aeroplane 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. | | | | | | | | | | | | |
<table>
<thead>
<tr>
<th>13</th>
<th>FEATURE TECHNICAL REQUIREMENT</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.8 R,G</td>
<td>Transport delay:</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Results required for applicable systems only.</td>
</tr>
</tbody>
</table>

A transport delay test may be used to demonstrate that the FSTD system response does not exceed 200 ms.
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 aeroplane 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 required. 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 aircraft from which the validation flight test data was 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. For aeroplanes certificated after 1 January 2002, the QTG should be supported by a validation data roadmap (VDR) as described in Attachment D of this Part. Data providers are encouraged to supply a VDR for older aeroplanes.

1.5 The table of FSTD validation tests in this appendix indicates the required tests. Unless noted otherwise, FSTD tests should represent aeroplane performance and handling qualities at operating mass and centre of gravity (cg) positions typical of normal operation. If a test is supported by aeroplane data at one extreme mass or cg position, another test supported by aeroplane data at mid-conditions or as close as possible to the other extreme should be included. Certain tests which are relevant only at one extreme 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 aeroplane (CCA) 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 aeroplane tests for FSTD data. Where applicable, flight test data should record:

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

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

1.7 The recording requirements of 1.6 a) and b) 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 CCA 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 aeroplane being simulated, and for which results cannot be provided, should be addressed in the QTG by an appropriate rationale included from the aeroplane 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. 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.
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 aeroplane 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 aeroplane 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 that have units of per cent, or parameters normally displayed in the cockpit in units of per cent (e.g. N1, N2, engine torque or power), then a percentage tolerance will be interpreted as an absolute tolerance unless otherwise specified (i.e. for an observation of 50 per cent N1 and a tolerance of 5 per cent, the acceptable range would be from 45 per cent to 55 per cent); and

   d) for parameters not displayed in units of per cent, 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 Authority.

2.5 Flight condition verification. When comparing the parameters listed to those of the aeroplane, sufficient data should also be provided to verify the correct flight condition. For example, to show the control force is within ±2.2 daN (5 lbf) in a static stability test, data to show correct airspeed, power, thrust or torque, aeroplane configuration, altitude, and other appropriate datum identification parameters should also be given. If comparing short-period dynamics, normal acceleration may be used to establish a match to the aeroplane, but airspeed, altitude, control input, aeroplane configuration, and other appropriate data should also be given. All airspeed values should be 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, Sections 1 (Performance) and 2 (Handling Qualities) are defined as follows:

   a) ground — on ground, independent of aeroplane configuration;

   b) take-off — gear down with flaps in any certified take-off position;

   c) second segment climb — gear up with flaps in any certified take-off position;

   d) clean — flaps and gear up;

   e) cruise — clean configuration at cruise altitude and airspeed;
f) approach — gear up or down with flaps at any normal approach position as recommended by the aeroplane manufacturer; and

g) landing — gear down with flaps in any certified landing position.

3. INFORMATION FOR VALIDATION TESTS

3.1 Engines

3.1.1 Tests are required to show the response of the Critical Engine Parameter to a rapid throttle movement for an engine acceleration and an engine deceleration. The procedure for evaluating the response is illustrated in Figures B-1 and B-2.

![Figure B-1. Engine acceleration](image-url)

- $A_{ga}$ = Critical engine parameter at go-around power
- $A_i$ = Critical engine parameter at idle power
- $t_{0.1}$ = Total time from initial throttle movement until a critical engine parameter reaches 10% of its total response above idle power
- $t_{0.9}$ = Total time from initial throttle movement until a critical engine parameter reaches 90% of its total response above idle power

Total response is the incremental change in the critical engine parameter from idle power to go-around power.
3.2 Control dynamics

3.2.1 General. The characteristics of an aeroplane flight control system have a major effect on handling qualities. A significant consideration in pilot acceptability of an aeroplane is the “feel” provided through the flight controls. Considerable effort is expended on aeroplane feel system design so that pilots will be comfortable and will consider the aeroplane desirable to fly. In order for an FSTD to be representative, it too should present the pilot with the proper feel: that of the aeroplane being simulated. Compliance with this requirement should be determined by comparing a recording of the control feel dynamics of the FSTD to actual aeroplane 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 aeroplane systems is essential. The required control dynamics tests are indicated in 2.b.1 through 2.b.3 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 aeroplanes with irreversible control systems, measurements may be obtained on the ground if proper pitot-static inputs are provided to represent airspeeds typical of those encountered in flight. Likewise, it may be shown that for some aeroplanes, take-off, cruise and landing configurations have like effects. Thus, one configuration may suffice. If either or both considerations apply, engineering validation or aeroplane manufacturer rationale should be submitted as justification for ground tests or for eliminating a configuration. For 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 aeroplane should show that the dynamic damping cycles (free response of the controls) match those of the aeroplane 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 aeroplane control system and, consequently, will enjoy the full tolerance specified for that period.

The damping tolerance should be applied to overshoots on an individual basis. Care should be taken when applying the tolerance to small overshoots since the significance of such overshoots becomes questionable. Only those overshoots larger than 5 per cent of the total initial displacement should be considered. The residual band, labelled $T(A_d)$ on Figure B-3 is ±5 per cent of the initial displacement amplitude $A_0$ 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 aeroplane data, the process should begin by overlaying or aligning the FSTD and aeroplane 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 aeroplane data. This procedure for evaluating the response is illustrated in Figure B-3.

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 aeroplane within ±10 per cent or ±0.05 s. Figure B-4 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.

3.2.2.2 **Tolerances.** The following table summarizes the tolerances, $T$, for underdamped systems. See Figure B-3 for an illustration of the referenced measurements.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T(P_0)$</td>
<td>±10 per cent of $P_0$ or ±0.05 s.</td>
</tr>
<tr>
<td>$T(P_1)$</td>
<td>±20 per cent of $P_1$ or ±0.05 s.</td>
</tr>
<tr>
<td>$T(P_2)$</td>
<td>±30 per cent of $P_2$ or ±0.05 s.</td>
</tr>
<tr>
<td>$T(P_n)$</td>
<td>±$10^{(n+1)}$ per cent of $P_n$ or ±0.05 s.</td>
</tr>
<tr>
<td>$T(A_n)$</td>
<td>±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).</td>
</tr>
<tr>
<td>$T(A_d)$</td>
<td>±5 per cent of $A_d$ = residual band or ±0.5 per cent of the maximum control travel = residual band.</td>
</tr>
</tbody>
</table>

±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.

---

**Figure B-3.** Underdamped step response

- $P$ = 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 $(0.1 A_d)$.
The following tolerance applies to the overdamped and critically damped systems only. See Figure B-4 for an illustration of the reference measurement.

\[ T(P_0) \pm 10 \text{ per cent of } P_0 \text{ or } \pm 0.05 \text{ s.} \]

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

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.

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).*
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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.

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 aeroplanes 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 of this Part. Figure B-5 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-5. Tolerances applied using the alternate reference line](image-url)
3.3  Ground effect

3.3.1  An FSTD to be used for take-off and landing should faithfully reproduce the aerodynamic changes which occur in ground effect. The parameters chosen for FSTD validation should be indicative of these changes. A dedicated test which will validate the aerodynamic ground effect characteristics should be undertaken. The choice of the test method and procedures to validate ground effect rests with the organization performing the flight tests; however, the duration of the flight test performed near the ground should be sufficient to validate the ground-effect model.

3.3.2  Acceptable tests for validation of ground effect should include one of the following:

a)  Level fly-bys. The level fly-bys should be conducted at a minimum of three heights within the ground effect, including one at no more than 10 per cent of the wingspan above the ground, one each at approximately 30 per cent and 50 per cent of the wingspan, where height refers to main gear tire height above the ground. In addition, one level-flight trim condition should be conducted out of ground effect, e.g. at 150 per cent of the wingspan.

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

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

3.3.3  The lateral-directional characteristics are also altered by ground effect. For example, because of changes in lift, roll damping is affected. The change in roll damping will affect other dynamic modes usually evaluated for FSTD validation. In fact, dutch roll dynamics, spiral stability and roll-rate for a given lateral control input are altered by ground effect. Steady heading side-slips will also be affected. These effects should be accounted for in the simulator modelling. Several tests such as “crosswind landing”, “one engine inoperative landing” and “engine failure on take-off” serve to validate lateral-directional ground effect since portions of them are accomplished while transiting heights at which ground effect is an important factor.

3.4  Engineering simulator — validation data

3.4.1  When a fully flight-test validated simulation is modified as a result of changes to the simulated aeroplane configuration, a qualified aeroplane 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;

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, an aeroplane manufacturer, or other approved data supplier, should:

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

3) is used to support aeroplane 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 Aeroplane 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 of this Part.

3.5 Motion system

3.5.1 General

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

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, tests 3.a, frequency response, and 3.b, turn-around check, is to demonstrate the performance of the motion system hardware and to check the integrity of the motion set-up with regard to calibration and wear. These tests are independent of the motion cueing software and should be considered as robotic tests.

3.5.3 Motion cueing fidelity tests

3.5.3.1 Frequency-domain based objective motion cueing test

3.5.3.1.1 Background. 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 simulator 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 simulator is accelerated momentarily in the forward direction to provide the onset cueing. This is considered the direct transfer relation. The simulator 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.

3.5.3.1.2 Frequency response test. This test requires 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. See Figure B-6. 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 aeroplanes. These tests can be run at any time deemed acceptable to the authority prior to and/or during the initial qualification.

![Figure B-6. Schematic of measured input and output relation for frequency-domain motion cueing test.](image-url)
### Table B-1. Motion cueing system transfer test matrix

<table>
<thead>
<tr>
<th>Test Signal Input</th>
<th>Pitch</th>
<th>Roll</th>
<th>Yaw</th>
<th>Surge</th>
<th>Sway</th>
<th>Heave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitch</td>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roll</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Yaw</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surge</td>
<td>7</td>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sway</td>
<td></td>
<td>9</td>
<td></td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heave</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.5.3.1.3 The frequency responses describe the relations between aircraft motions and simulator motions as defined in Table B-1. The relations are explained below per individual test. 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.

1. FSTD pitch response to aircraft pitch input
2. FSTD surge specific force response due to aircraft pitch input
3. FSTD roll response to aircraft roll input
4. FSTD sway specific force response due to aircraft roll input
5. FSTD yaw response to aircraft yaw input
6. FSTD surge specific force response to aircraft surge input
7. FSTD pitch rate and pitch acceleration response to aircraft surge input
8. FSTD sway specific force response to aircraft sway input
9. FSTD roll rate and pitch acceleration response to aircraft sway input
10. FSTD heave specific force response to aircraft heave input

3.5.3.1.4 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 twelve discrete frequencies for these tests range from 0.100 rad/s to 15.849 rad/s and are given in Attachment F, Table F-1. The relationship between the frequency and corresponding measured modulus and phase defines the system transfer function. This test requires that, for each degree-of-freedom, measurements at the twelve specified frequencies should be taken.

3.5.3.1.5 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 Attachment F, Tables F-2 and F-4.

3.5.3.1.6 Data recording. The measured parameters for each test should include the modulus and phase as prescribed in Attachment F, paragraph 2.2, for the tests delineated in Table B-1. The modulus indicates 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.
3.5.3.1.7  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 points downward. The frames of reference are defined in Attachment F, paragraph 7.4.

3.5.3.1.8  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.

3.5.3.1.9  Presentation of results. The measured modulus and phase should be tabulated for the twelve frequencies and for each of the transfer relations given in Table B-1. The results should also be plotted for each component in a modulus versus phase plot. The modulus should range from 0.0 to 1.0 along the horizontal axis, and the absolute value of the phase from 0 to 180 degrees along the vertical axis. An example is shown in Figure B-7.

3.5.3.1.10 Tolerances. Through the ICFQ mechanism (refer to Appendix D of this Part), the tolerances will be implemented into this test after more testing and when sufficient experience is gained.

![Figure B-7. Example plot of frequency response test of a motion cueing system. The frequency varies along the curved line.](image-url)
3.5.3.2 Time-domain based objective motion cueing test

A time-domain based objective motion cueing test, which would complement the above frequency-domain test, is currently being tested and evaluated through the ICFQ mechanism (refer to Appendix D of this Part). This test will help quantify the response of the motion cueing system. The testing methodology, criteria and tolerances for this test will be implemented into this section after more testing and when sufficient experience is gained.

3.5.4 Motion system repeatability. The intent of this test is to ensure that the motion system software and motion system hardware have not degraded or changed over time. This 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 the aeroplane cg to the pilot reference point with a minimum amplitude of 5 °/s², 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.

3.5.5 Motion vibrations

3.5.5.1 Presentation of results. The characteristic motion vibrations are a means to verify that the FSTD can reproduce the frequency content of the aeroplane when flown in specific conditions. The test results should be presented as a Power Spectral Density (PSD) plot with frequencies on the horizontal axis and amplitude on the vertical axis. The aeroplane data and FSTD data should be presented in the same format with the same scaling, for frequencies up to at least 20 Hz. The algorithms used for generating the FSTD data should be the same as those used for the aeroplane 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 vertical and lateral axes should be presented. Longitudinal axis should be presented if either the aeroplane’s or simulator’s vibrations are significant and, if the longitudinal axis is not presented, a rationale should be provided.

3.5.5.2 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 aeroplane 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 $1 \times 10^{-3} (g_{rms})^2/Hz$ would describe a heavy buffet and may be seen in the deep stall regime. On the other hand, a $1 \times 10^{-6} (g_{rms})^2/Hz$ buffet is almost not perceivable but may represent a flap buffet at low speed. The previous two examples differ in magnitude by 1 000. On a PSD plot
this represents three decades (one decade is a change in order of magnitude of 10; two decades is a change in order of magnitude of 100; etc.).

3.6 Visual systems

3.6.1 General. Visual systems should be tested in accordance with table of FSTD validation tests, paragraph 4.

3.6.2 Visual ground segment. See test 4.b.

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 aeroplane can be readily determined using approach/runway lighting and flight deck 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 aeroplane), pilot’s eye reference point, flight deck cut-off angle, etc., used to accurately make visual ground segment (VGS) scene content calculations (see Figure B-8).

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

![Figure B-8. VGS scene content calculations](image-url)
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 relative to the aircraft 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 +/-53.3 cm (+/-21 inches). Greater eye spacings should be accompanied by an explanation of any additional tolerance required.

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. This tolerance applies to the central 200 degrees by 40 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 mirror.

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

The 200˚ × 40˚ FOV is divided up into 3 zones to set tolerances for relative geometry as shown in Figure B-9.

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 −90, −60, −30, 0 and +15 degrees in azimuth, measure all visible 1 degree points from the −10˚ point to the lowest visible point.

**Note.**— Not all points depicted on the pattern are measured, but they may be measured if observation suggests a problem.

b) From the co-pilot's eye position, measure every visible 5 degree point on the vertical lines and horizontal lines. Also, at +90, +60, +30, 0 and -15 degrees in azimuth, measure all visible 1 degree points from the −10˚ point to the lowest visible point.

**Note.**— Not all points depicted on the pattern are measured, but they may be measured if observation suggests a problem.
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.
- 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 deg. more or less than the adjacent gap when in zone 1.

e) For larger fields of view, there should be no distracting discontinuities outside this area.

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 Laser speckle contrast ratio (Laser Projection system).

The objective measure of speckle contrast that is described in the following 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, an 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:
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\[ C = \sqrt{\frac{\langle I^2 \rangle - \langle I \rangle^2}{\langle I \rangle^2}}, \]

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

\[ \langle I \rangle = \frac{\int_{FOV} I(x, y) dA}{\int_{FOV} dA} \]

Hence:

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

3.6.4.2 Speckle Measurement

The intensity profile \(I(x, y)\) can be measured with a charge-coupled device (CCD) camera. The set-up 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 \(\frac{\int_{FOV} I(x, y) dA}{\int_{FOV} dA}\) translates into \(\sum_{FOV} I_{m,n}\).

Therefore,

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

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 aeroplane is very complex and changes with atmospheric conditions, aeroplane configuration, airspeed, altitude, power settings, etc. Thus, flight deck sounds are an important component of the flight deck operational environment and as such provide valuable information to the flight crew. These aural cues can either assist the crew, as an indication of an abnormal situation, or hinder the crew, as a distraction or nuisance. For effective training, the FSTD should provide flight deck sounds that are perceptible to the pilot during normal, abnormal and emergency operations and that are comparable to those of the aeroplane. 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 propulsion. For FSTDs with multiple propulsion configurations, any condition listed in Appendix B, Section 5 (Sound systems) that is identified by the aeroplane manufacturer as significantly different, due to a change in propulsion system (engine or propeller), should be presented for evaluation as part of the QTG.

3.7.3 Data and data collection system

3.7.3.1 Information provided to the FSTD manufacturer should comply with the IATA Flight Simulator Design and Performance Data Requirements, Sixth Edition, 2000, 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, Section 5, 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 aeroplane 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 aeroplane and the extraneous noise from other locations in the building. Background noise can seriously impact the correct simulation of aeroplane sounds, so the goal should be to keep the background noise
below the aeroplane sounds. In some cases, the sound level of the simulation can be increased to compensate for the background noise. However, this approach is limited by the specified tolerances and by the subjective acceptability of the sound environment to the evaluation pilot.

3.7.7.2 The acceptability of the background noise levels is dependent upon the normal sound levels in the aeroplane or class of aeroplane being represented. Background noise levels that fall below the lines defined by the following points may be acceptable (refer to Figure B-10):

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

These limits are for unweighted 1/3 octave band sound levels. Meeting these limits for background noise does not ensure an acceptable FSTD. Aeroplane 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 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.

![Figure B-10. 1/3 Octave band frequency (Hz).](image)

3.7.8 \textit{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 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-2).

Table B-2. Example of recurrent frequency response test tolerance

<table>
<thead>
<tr>
<th>Band centre frequency</th>
<th>Initial results (dBSPL)</th>
<th>Recurrent results (dBSPL)</th>
<th>Absolute difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>75.0</td>
<td>73.8</td>
<td>1.2</td>
</tr>
<tr>
<td>63</td>
<td>75.9</td>
<td>75.6</td>
<td>0.3</td>
</tr>
<tr>
<td>80</td>
<td>77.1</td>
<td>76.5</td>
<td>0.6</td>
</tr>
<tr>
<td>100</td>
<td>78.0</td>
<td>78.3</td>
<td>0.3</td>
</tr>
<tr>
<td>125</td>
<td>81.9</td>
<td>81.3</td>
<td>0.6</td>
</tr>
<tr>
<td>160</td>
<td>79.8</td>
<td>80.1</td>
<td>0.3</td>
</tr>
<tr>
<td>200</td>
<td>83.1</td>
<td>84.9</td>
<td>1.8</td>
</tr>
<tr>
<td>250</td>
<td>78.6</td>
<td>78.9</td>
<td>0.3</td>
</tr>
<tr>
<td>315</td>
<td>79.5</td>
<td>78.3</td>
<td>1.2</td>
</tr>
<tr>
<td>400</td>
<td>80.1</td>
<td>79.5</td>
<td>0.6</td>
</tr>
<tr>
<td>500</td>
<td>80.7</td>
<td>79.8</td>
<td>0.9</td>
</tr>
<tr>
<td>630</td>
<td>81.9</td>
<td>80.4</td>
<td>1.5</td>
</tr>
<tr>
<td>800</td>
<td>73.2</td>
<td>74.1</td>
<td>0.9</td>
</tr>
<tr>
<td>1 000</td>
<td>79.2</td>
<td>80.1</td>
<td>0.9</td>
</tr>
<tr>
<td>1 250</td>
<td>80.7</td>
<td>82.8</td>
<td>2.1</td>
</tr>
<tr>
<td>1 600</td>
<td>81.6</td>
<td>78.6</td>
<td>3.0</td>
</tr>
<tr>
<td>2 000</td>
<td>76.2</td>
<td>74.4</td>
<td>1.8</td>
</tr>
<tr>
<td>2 500</td>
<td>79.5</td>
<td>80.7</td>
<td>1.2</td>
</tr>
<tr>
<td>3 150</td>
<td>80.1</td>
<td>77.1</td>
<td>3.0</td>
</tr>
<tr>
<td>4 000</td>
<td>78.9</td>
<td>78.6</td>
<td>0.3</td>
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<tr>
<td>5 000</td>
<td>80.1</td>
<td>77.1</td>
<td>3.0</td>
</tr>
<tr>
<td>6 300</td>
<td>80.7</td>
<td>80.4</td>
<td>0.3</td>
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<tr>
<td>8 000</td>
<td>84.3</td>
<td>85.5</td>
<td>1.2</td>
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<tr>
<td>10 000</td>
<td>81.3</td>
<td>79.8</td>
<td>1.5</td>
</tr>
<tr>
<td>12 500</td>
<td>80.7</td>
<td>80.1</td>
<td>0.6</td>
</tr>
<tr>
<td>16 000</td>
<td>71.1</td>
<td>71.1</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td></td>
<td><strong>1.1</strong></td>
</tr>
</tbody>
</table>
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 aeroplane cases, then it is not required to rerun those cases during recurrent evaluations. If aeroplane cases are rerun during recurrent evaluations, then the results may be compared against initial evaluation results rather than aeroplane master data.

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

a) variation of data between tail numbers;

b) frequency response of microphones;

c) repeatability of the measurements; 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

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PERFORMANCE</td>
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</tr>
<tr>
<td>1.a Taxi</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>1.a (1) Minimum radius turn.</td>
<td>±0.9 m (3 ft) or ±20% of aeroplane turn radius.</td>
<td>Ground.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Plot both main and nose gear loci and key engine parameter(s). Data for no brakes and the minimum thrust required to maintain a steady turn except for aeroplanes requiring asymmetric thrust or braking to achieve the minimum radius turn.</td>
</tr>
<tr>
<td>1.a (2) Rate of turn versus nosewheel steering angle (NWA).</td>
<td>±10% or ±2°/s of turn rate.</td>
<td>Ground.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Record for a minimum of two speeds, greater than minimum turning radius speed with one at a typical taxi speed, and with a spread of at least 5 kt.</td>
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</tr>
<tr>
<td>1.b Take-off</td>
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<td></td>
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<td>Note.— All aeroplane manufacturer commonly-used certificated take-off flap settings should be demonstrated at least once either in minimum unstick speed (1.b.3), normal take-off (1.b.4), critical engine failure on take-off (1.b.5) or crosswind take-off (1.b.6).</td>
</tr>
<tr>
<td>1.b (1) Ground acceleration time and distance.</td>
<td>±1.5 s or ±5% of time; and ±61 m (200 ft) or ±5% of distance.</td>
<td>Take-off.</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Acceleration time and distance should be recorded for a minimum of 80% of the total time from brake release to V¢. May be combined with normal take-off (1.b.4) or rejected take-off (1.b.7). Plotted data should be shown using appropriate scales for each portion of the manoeuvre.</td>
<td></td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
<td>Type III</td>
<td>Type IV</td>
<td>Type V</td>
<td>Type VI</td>
<td>Type VII</td>
<td>COMMENTS</td>
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<tr>
<td>1.b</td>
<td>(2) Minimum control speed, ground ($V_{mcg}$) using aerodynamic controls only per applicable airworthiness requirement or alternative engine inoperative test to demonstrate ground control characteristics.</td>
<td>±25% of maximum aeroplane lateral deviation reached or ±1.5 m (5 ft). For aeroplanes with reversible flight control systems: ±10% or ±2.2 daN (5 lbf) rudder pedal force.</td>
<td>Take-off.</td>
<td>✔</td>
<td>☑</td>
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</tr>
</tbody>
</table>

Engine failure speed should be within ±1 kt of aeroplane engine failure speed. Engine thrust decay should be that resulting from the mathematical model for the engine applicable to the FSTD under test. If the modelled engine is not the same as the aeroplane manufacturer’s flight test engine, a further test may be run with the same initial conditions using the thrust from the flight test data as the driving parameter. To ensure only aerodynamic control, nosewheel steering should be disabled (i.e. castored) or the nosewheel held slightly off the ground.

If a $V_{mcg}$ test is not available, an acceptable alternative is a flight test snap engine deceleration to idle at a speed between $V_1$ and $V_{1-10}$ kt, followed by control of heading using aerodynamic control only and recovery should be achieved with the main gear on the ground.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.b</td>
<td>(3) Minimum unstick speed ($V_{mu}$) or equivalent test to demonstrate early rotation take-off characteristics.</td>
<td>±3 kt airspeed.</td>
<td>±1.5° pitch angle.</td>
<td>Take-off.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>$V_{mu}$ is defined as the minimum speed at which the last main landing gear leaves the ground. Main landing gear strut compression or equivalent air/ground signal should be recorded. If a $V_{mu}$ test is not available, alternative acceptable flight tests are a constant high-attitude take-off run through main gear lift-off or an early rotation take-off. If either of these alternative solutions is selected, aft body contact/tail strike protection functionality, if present on the aeroplane, should be active. Record time history data from 10 knots before start of rotation until at least 5 seconds after the occurrence of main gear lift-off.</td>
<td></td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
<td>Type III</td>
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<td>Type VII</td>
<td>COMMENTS</td>
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<tr>
<td>1.b</td>
<td>(4) Normal take-off.</td>
<td>±3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA. ±6 m (20 ft) height. For aeroplanes with reversible flight control systems: ±2.2 daN (5 lb) or ±10% of column force.</td>
<td>Take-off.</td>
<td>✓</td>
<td>✓</td>
<td>Data required for near maximum certificated take-off mass at mid centre of gravity location and light take-off mass at an aft centre of gravity location. If the aeroplane has more than one certificated take-off configuration, a different configuration should be used for each mass. Record take-off profile from brake release to at least 61 m (200 ft) AGL. The test may be used for ground acceleration time and distance (1.b.1). Plotted data should be shown using appropriate scales for each portion of the manoeuvre.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.b</td>
<td>(5) Critical engine failure on take-off.</td>
<td>±3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA. ±6 m (20 ft) height. ±2° roll angle. ±2° side-slip angle. ±3° heading angle. For aeroplanes with reversible flight control systems: ±2.2 daN (5 lb) or ±10% of column force; ±1.3 daN (3 lb) or ±10% of wheel force; and ±2.2 daN (5 lb) or ±10% of rudder pedal force.</td>
<td>Take-off.</td>
<td>✓</td>
<td>✓</td>
<td>Record take-off profile to at least 61 m (200 ft) AGL. Engine failure speed should be within ±3 kt of aeroplane data. Test at near MCTM.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
<td>Type III</td>
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<td>Type V</td>
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<td>Type VII</td>
<td>COMMENTS</td>
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<tr>
<td>1.b (6) Crosswind take-off.</td>
<td>± 3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA. ±6 m (20 ft) height. ±2° roll angle. ±2° side-slip angle. ±3° heading angle. Correct trends at ground speeds below 40 kt for rudder/ pedal and heading angle. For aeroplanes with reversible flight control systems: ±2.2 daN (5 lbf) or ±10% of column force; ±1.3 daN (3 lbf) or ±10% of wheel force; and ±2.2 daN (5 lbf) or ±10% of rudder pedal force.</td>
<td>Take-off.</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>Record take-off profile from brake release to at least 61 m (200 ft) AGL. This test requires test data, including wind profile, for a crosswind component of at least 60% of the aeroplane performance data value measured at 10 m (33 ft) above the runway. Wind components should be provided as headwind and crosswind values with respect to the runway.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
<td>Type III</td>
<td>Type IV</td>
<td>Type V</td>
<td>Type VI</td>
<td>Type VII</td>
<td>COMMENTS</td>
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<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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<tr>
<td>1.b</td>
<td>(7) Rejected take-off.</td>
<td>±5% of time or ±1.5 s.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Record at mass near MCTM. Speed for reject should be at least 80% of V₁. Autobrakes will be used where applicable. Maximum braking effort, auto or manual.</td>
</tr>
<tr>
<td></td>
<td>±7.5% of distance or ±76 m (250 ft).</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Where a maximum braking demonstration is not available, an acceptable alternative is a test using approximately 80% braking and full reverse, if applicable.</td>
</tr>
<tr>
<td></td>
<td>For type I, III and VI devices:</td>
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<td></td>
<td>Time and distance should be recorded from brake release to a full stop.</td>
</tr>
<tr>
<td></td>
<td>±5% of time or ±1.5 s.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>For type I, III and VI devices, record time for at least 80% of the time segment from initiation of the rejected take-off to full stop.</td>
</tr>
<tr>
<td>1.b</td>
<td>(8) Dynamic engine failure after take-off.</td>
<td>±2°/s or ±20% of body angular rates.</td>
<td></td>
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<td></td>
<td></td>
<td>✓</td>
<td>Engine failure speed should be within ±3 kt of aeroplane data. Engine failure may be a snap deceleration to idle.</td>
</tr>
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<td>✓</td>
<td>Record hands-off from 5 s before engine failure to +5 s or 30° roll angle, whichever occurs first.</td>
</tr>
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<td>Note. — For safety considerations, aeroplane flight test may be performed out of ground effect at a safe altitude, but with correct aeroplane configuration and airspeed.</td>
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<td>CCA: Test in normal and non-normal control state.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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</tr>
<tr>
<td>1.c</td>
<td>Climb</td>
<td>±3 kt airspeed.</td>
<td>C</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Flight test data are preferred; however, aeroplane performance manual data are an acceptable alternative. Record at nominal climb speed and mid initial climb altitude. FSTD performance is to be recorded over an interval of at least 300 m (1 000 ft). For type I, II, III, IV and VI devices, this test may be a snapshot test.</td>
</tr>
<tr>
<td>1.c</td>
<td>(1) Normal climb all engines operating. ±0.5 m/s (100 ft/ min) or ±5% of rate of climb.</td>
<td>Clean.</td>
<td>✓</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Flight test data are preferred; however, aeroplane performance manual data are an acceptable alternative. Record at nominal climb speed and mid initial climb altitude. FSTD performance is to be recorded over an interval of at least 300 m (1 000 ft). For type I, II, III, IV and VI devices, this test may be a snapshot test.</td>
</tr>
<tr>
<td>1.c</td>
<td>(2) One-engine-inoperative 2nd segment climb. ±3 kt airspeed. ±0.5 m/s (100 ft/ min) or ±5% of rate of climb, but not less than aeroplane performance data requirements.</td>
<td>2nd segment climb.</td>
<td>✓</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Flight test data are preferred; however, aeroplane performance manual data are an acceptable alternative. Record at nominal climb speed. FSTD performance is to be recorded over an interval of at least 300 m (1 000 ft). Test at WAT (weight, altitude or temperature) limiting condition. For type I, II, III, IV and VI devices, this test may be a snapshot test.</td>
</tr>
<tr>
<td>1.c</td>
<td>(3) One-engine-inoperative en-route climb. ±10% of time. ±10% of distance. ±10% of fuel used.</td>
<td>Clean.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Flight test data or aeroplane performance manual data may be used. Test for at least a 1550 m (5 000 ft) segment.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
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</tr>
<tr>
<td>1.c</td>
<td>(4) One-engine-inoperative approach climb for aeroplanes with icing accountability if provided in the aeroplane performance data for this phase of flight.</td>
<td>±3 kt airspeed. ±0.5 m/s (100 ft/ min) or ±5% rate of climb, but not less than aeroplane performance data.</td>
<td>Approach.</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>Flight test data or aeroplane performance manual data may be used. FSTD performance to be recorded over an interval of at least 300 m (1 000 ft). Test near maximum certificated landing mass as may be applicable to an approach in icing conditions. Aeroplane should be configured with all anti-ice and de-ice systems operating normally, gear up and go-around flap. All icing accountability considerations, in accordance with the aeroplane performance data for an approach in icing conditions, should be applied.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.d</td>
<td>Cruise/Descent</td>
<td>±5% of time.</td>
<td>Cruise.</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>Time required to increase airspeed a minimum of 50 kt, using maximum continuous thrust rating or equivalent. For aeroplanes with a small operating speed range, speed change may be reduced to 80% of operational speed change.</td>
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<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
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</tr>
<tr>
<td>1.d</td>
<td>(2) Level flight deceleration.</td>
<td>±5% of time.</td>
<td>Cruise.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>Time required to decrease airspeed a minimum of 50 kt, using idle power. For aeroplanes with a small operating speed range, speed change may be reduced to 80% of operational speed change.</td>
<td></td>
</tr>
<tr>
<td>1.d</td>
<td>(3) Cruise performance.</td>
<td>±0.05 EPR or ±3% N1 or ±5% of torque. ±5% of fuel flow.</td>
<td>Cruise.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>The test may be a single snapshot showing instantaneous fuel flow, or a minimum of two consecutive snapshots with a spread of at least 3 minutes in steady flight.</td>
<td></td>
</tr>
<tr>
<td>1.d</td>
<td>(4) Idle descent.</td>
<td>±3 kt airspeed. ±1.0 m/s (200 ft/min) or ±5% of rate of descent.</td>
<td>Clean.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>Idle power stabilized descent at normal descent speed at mid altitude. FSTD performance to be recorded over an interval of at least 300 m (1 000 ft).</td>
<td></td>
</tr>
<tr>
<td>1.d</td>
<td>(5) Emergency descent.</td>
<td>±5 kt airspeed. ±1.5 m/s (300 ft/min) or ±5% of rate of descent.</td>
<td>As per aeroplane performance data.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>Stabilized descent to be conducted with speed brakes extended if applicable, at mid altitude and near $V_{mo}$ or according to emergency descent procedure. FSTD performance to be recorded over an interval of at least 900 m (3 000 ft).</td>
<td></td>
</tr>
<tr>
<td>TEST</td>
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<td>FLIGHT CONDITION</td>
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<td>Type II</td>
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<tr>
<td>1.e</td>
<td>Stopping</td>
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<tr>
<td>1.e (1)</td>
<td>Deceleration time and distance, manual wheel brakes, dry runway, no reverse thrust.</td>
<td>±1.5 s or ±5% of time. For distances up to 1 220 m (4 000 ft), the smaller of ±61 m (200 ft) or ±10% of distance. For distances greater than 1 220 m (4 000 ft), ±5% of distance.</td>
<td>Landing.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>Time and distance should be recorded for at least 80% of the total time from touchdown to a full stop. Position of ground spoilers and brake system pressure should be plotted (if applicable). Data required for medium and near maximum certificated landing mass. Engineering data may be used for the medium mass condition.</td>
<td></td>
</tr>
<tr>
<td>1.e (2)</td>
<td>Deceleration time and distance, reverse thrust, no wheel brakes, dry runway.</td>
<td>±1.5 s or ±5% of time; and the smaller of ±61 m (200 ft) or ±10% of distance.</td>
<td>Landing.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>Time and distance should be recorded for at least 80% of the total time from initiation of reverse thrust to full thrust reverser minimum operating speed. Position of ground spoilers should be plotted (if applicable). Data required for medium and near maximum certificated landing mass. Engineering data may be used for the medium mass condition.</td>
<td></td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
<td>Type III</td>
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</tr>
<tr>
<td>1.e (3)</td>
<td>Stopping distance, wheel brakes, wet runway.</td>
<td>±61 m (200 ft) or ±10% of distance.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>Either flight test or manufacturer's performance manual data should be used, where available. Engineering data, based on dry runway flight test stopping distance and the effects of contaminated runway braking coefficients, are an acceptable alternative.</td>
</tr>
<tr>
<td>1.e (4)</td>
<td>Stopping distance, wheel brakes, icy runway.</td>
<td>±61 m (200 ft) or ±10% of distance.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>Either flight test or manufacturer's performance manual data should be used, where available. Engineering data, based on dry runway flight test stopping distance and the effects of contaminated runway braking coefficients, are an acceptable alternative.</td>
</tr>
<tr>
<td>1.f</td>
<td>Engines</td>
<td></td>
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<tr>
<td>1.f (1)</td>
<td>Acceleration</td>
<td>±10% Ti or ±0.25 s; and ±10% Tt or ±0.25 s.</td>
<td>Approach or landing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>Ti = total time from initial throttle movement until a critical engine parameter reaches 10% of its total response above idle power. Tt = total time from initial throttle movement until a critical engine parameter reaches 90% of its total response above idle power. Total response is the incremental change in the critical engine parameter from idle power to go-around power. Refer to paragraph 3.1, Figure B-1 of this appendix.</td>
</tr>
</tbody>
</table>

Ti = total time from initial throttle movement until a critical engine parameter reaches 10% of its total response above idle power. 
Tt = total time from initial throttle movement until a critical engine parameter reaches 90% of its total response above idle power. 
Total response is the incremental change in the critical engine parameter from idle power to go-around power. 
Refer to paragraph 3.1, Figure B-1 of this appendix.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.f</td>
<td>(2) Deceleration.</td>
<td>±10% Ti or ±0.25 s; and ±10% Tt or ±0.25 s.</td>
<td>Ground.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Ti = total time from initial throttle movement until a critical engine parameter reaches 10% of its total response below maximum take-off power. Tt = total time from initial throttle movement until a critical engine parameter reaches 90% of its total response below maximum take-off power. Total response is the incremental change in the critical engine parameter from maximum take-off power to idle power. Refer to paragraph 3.1, Figure B-2 of this appendix.</td>
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<tr>
<td></td>
<td>For type I, III and VI devices:</td>
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<td></td>
<td>±10% Ti or ± 1 s; and ±10% Tt or ± 1 s.</td>
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<tr>
<td></td>
<td>For type II and IV devices:</td>
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<td></td>
<td></td>
<td>±10% Ti or ± 1 s; and ±10% Tt or ± 1 s.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
<td>Type III</td>
<td>Type IV</td>
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<td>Type VI</td>
<td>Type VII</td>
<td>COMMENTS</td>
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<td>2</td>
<td>HANDLING QUALITIES</td>
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</table>

Note 1.— Pitch, roll and yaw 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 aeroplane 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. 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. Such a permanent installation could be used without any time being lost for the installation of external devices. Static and dynamic flight control tests should be accomplished at the same feel or impact pressures as the validation data where applicable.

Note 2.— FSTD testing from the second set of pilot controls is only required 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.

2.a Static control checks

Note.— Testing of position versus force is not applicable if forces are generated solely by use of aeroplane hardware in the FSTD.

2.a (1) Pitch controller position versus force and surface position calibration. ±0.9 daN (2 lbf) breakout. ±2.2 daN (5 lbf) or ±10% of force. ±2° elevator angle. Ground. Approach. Uninterrupted control sweep to stops. Test results should be validated with in-flight data from tests such as longitudinal static stability, stalls, etc. Uninterrupted control sweep to stops. Test results should be validated with in-flight data from tests such as longitudinal static stability, stalls, etc. Control forces and travel should broadly correspond to that of the replicated class of aeroplane.

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</thead>
<tbody>
<tr>
<td></td>
<td>±0.9 daN (2 lbf) breakout.</td>
<td>✓ PPL CPT</td>
<td>✓</td>
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<tr>
<td></td>
<td>±2.2 daN (5 lbf) or ±10% of force.</td>
<td>✓ CPL &amp; M</td>
<td>✓</td>
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<td></td>
<td>±2° elevator angle.</td>
<td>✓ MPL1</td>
<td>✓</td>
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<tr>
<td></td>
<td>±0.9 daN (2 lbf) breakout.</td>
<td>✓ C T &amp; M</td>
<td>✓</td>
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<tr>
<td></td>
<td>±2.2 daN (5 lbf) or ±10% of force.</td>
<td>✓ C T &amp; M</td>
<td>✓</td>
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</table>

Uninterrupted control sweep to stops. Test results should be validated with in-flight data from tests such as longitudinal static stability, stalls, etc.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.a</td>
<td>(2) Roll controller position versus force and surface position calibration.</td>
<td>±0.9 daN (2 lbf) breakout. Ground.</td>
<td>✓ PPL CPT &amp; M MPL1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Uninterrupted control sweep to stops. Test results should be validated with in-flight data from tests such as engine-out trims, steady state side-slip, etc.</td>
<td></td>
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<tr>
<td></td>
<td>Roll controller position versus force.</td>
<td>±1.3 daN (3 lbf) or ±10% of force. ±2° aileron angle. ±3° spoiler angle.</td>
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<tr>
<td></td>
<td></td>
<td>±0.9 daN (2 lbf) breakout.</td>
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<tr>
<td></td>
<td></td>
<td>±1.3 daN (3 lbf) or ±10% of force.</td>
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<tr>
<td>2.a</td>
<td>(3) Rudder pedal position versus force and surface position calibration.</td>
<td>±2.2 daN (5 lbf) breakout. Ground.</td>
<td>✓ PPL CPT &amp; M MPL1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Uninterrupted control sweep to stops. Test results should be validated with in-flight data from tests such as engine-out trims, steady state side-slip, etc.</td>
<td></td>
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<tr>
<td></td>
<td>Rudder pedal position versus force.</td>
<td>±2.2 daN (5 lbf) or ±10% of force. ±2° rudder angle.</td>
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<tr>
<td></td>
<td></td>
<td>±2.2 daN (5 lbf) breakout.</td>
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<tr>
<td></td>
<td></td>
<td>±2.2 daN (5 lbf) or ±10% of force.</td>
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<tr>
<td>2.a</td>
<td>(4) Nosewheel steering controller force and position calibration.</td>
<td>±0.9 daN (2 lbf) breakout. Ground.</td>
<td>✓ PPL CPT &amp; M MPL1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Uninterrupted control sweep to stops.</td>
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<tr>
<td></td>
<td></td>
<td>±1.3 daN (3 lbf) or ±10% of force. ±2° NWA.</td>
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<tr>
<td>2.a</td>
<td>(5) Rudder pedal steering calibration.</td>
<td>±2° NWA. Ground.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Uninterrupted control sweep to stops.</td>
<td></td>
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<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
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<tr>
<td>2.a 6</td>
<td>Pitch trim versus surface position calibration.</td>
<td>±0.5° trim angle.</td>
<td>Ground</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>The purpose of the test is to compare FSTD surface position and indicator against the software value.</td>
</tr>
<tr>
<td></td>
<td>±1.0° trim angle.</td>
<td>Ground</td>
<td>✓</td>
<td>C</td>
<td>T</td>
<td>&amp; M</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2.a 7</td>
<td>Pitch trim rate.</td>
<td>±10% of trim rate (°/s) or ±0.1°/s trim rate.</td>
<td>Ground and approach</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Trim rate to be checked at pilot primary induced trim rate (ground) and autopilot or pilot primary trim rate in-flight at go-around flight conditions. For CCA, representative flight test conditions should be used.</td>
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<tr>
<td>TEST</td>
<td>TOLERANCE</td>
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<tr>
<td>2.a</td>
<td>Alignment of cockpit throttle lever versus selected engine parameter.</td>
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</tbody>
</table>

When matching engine parameters:

- ±5° of TLA.
- ±3% N1 or ±0.03 EPR or ±3% torque, or equivalent.
- Where the levers do not have angular travel, a tolerance of ±2 cm (±0.8 in) applies.

<table>
<thead>
<tr>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>C T &amp; M</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simultaneous recording for all engines. The tolerances apply against aeroplane data. For aeroplanes with throttle detents, all detents to be presented and at least one position between detents/ endpoints (where practical). For aeroplanes without detents, end points and at least three other positions are to be presented. Data from a test aeroplane or engineering test bench are acceptable, provided the correct engine controller (both hardware and software) is used. In the case of propeller-driven aeroplanes, if an additional lever, usually referred to as the propeller lever, is present, it should also be checked. This test may be a series of snapshot tests.</td>
</tr>
<tr>
<td>TEST</td>
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<tr>
<td>------</td>
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<tr>
<td>2.a</td>
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<td>TEST</td>
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<tr>
<td>2.b</td>
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</tbody>
</table>

**Note.**— Tests 2.b.1, 2.b.2 and 2.b.3 are not applicable for FSTDs where the control forces are completely generated within the aeroplane controller unit installed in the FSTD. Power setting may be that required for level flight unless otherwise specified. See paragraph 3.2 of this appendix.

<table>
<thead>
<tr>
<th>2.b</th>
<th>(1) Pitch control. (ctd next page)</th>
<th>For underdamped systems (as per Figure B-3 of this Appendix):</th>
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</thead>
</table>
|      | T(P0) ±10% of P0 or ±0.05 s. | Take-off, cruise and landing. | ✓ | ✓ | ✓ | Data should be for normal control displacements in both directions (approximately 25% to 50% of full throw or approximately 25% to 50% of maximum allowable pitch controller deflection for flight conditions limited by the manoeuvring load envelope).
|      | T(P1) ±20% of P1 or ±0.05 s. | | | | | Tolerances apply against the absolute values of each period (considered independently).
|      | T(P2) ±30% of P2 or ±0.05 s. | | | | | n = the sequential period of a full oscillation.
|      | T(Pn) ±10*(n+1)% of Pn | | | | | Refer to paragraphs 3.2.2, 3.2.3, 3.2.4 and 3.2.5 of this Appendix.
<p>|      | T(An) ±10% of Amax, where Amax is the largest amplitude or ±0.5% of the total control travel (stop to stop). | | | | | |
|      | T(Ad) ±5% of A = residual band or ±0.5% of the maximum control travel = residual band. | | | | | |
|      | ±1 significant overshoots (minimum of 1 significant overshoot). | | | | | |
|      | Steady state position within residual band. | | | | | |</p>
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
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<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.b</td>
<td>(1) Pitch control (ctd).</td>
<td>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. For overdamped and critically damped systems only, the following tolerance applies: T(P₀) ±10% of P₀ or ±0.05 s.</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>For overdamped and critically damped systems, see Figure B-4 of Appendix B for an illustration of the reference measurement.</td>
</tr>
<tr>
<td>2.b</td>
<td>(2) Roll control.</td>
<td>Same as 2.b.1.</td>
<td>Take-off, cruise and landing.</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
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<td>Type VII</td>
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<tr>
<td>2.b</td>
<td>(3) Yaw control.</td>
<td>Same as 2.b.1.</td>
<td>Take-off, cruise and landing.</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>Data should be for normal control displacement (approximately 25% to 50% of full throw). Refer to paragraphs 3.2.2, 3.2.3, 3.2.4 and 3.2.5 of this Appendix.</td>
</tr>
<tr>
<td>2.b</td>
<td>(4) Small control inputs — pitch.</td>
<td>±0.15°/s body pitch rate or ±20% of peak body pitch rate applied throughout the time history.</td>
<td>Approach or landing.</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0.5 to 2°/s pitch rate). Test in both directions. Show time history data from 5 s before until at least 5 s after initiation of control input. If a single test is used to demonstrate both directions, there should be a minimum of 5 s before control reversal to the opposite direction. <strong>CCA</strong>: Test in normal and non-normal control state.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
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<tr>
<td>2.b</td>
<td>(5) Small control inputs — roll.</td>
<td>±0.15°/s body roll rate or ±20% of peak body roll rate applied throughout the time history.</td>
<td>Approach or landing.</td>
<td>✔️</td>
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<td>Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0.5 to 2°/s roll rate). Test in one direction. For aeroplanes that exhibit non-symmetrical behaviour, test in both directions. Show time history data from 5 s before until at least 5 s after initiation of control input. If a single test is used to demonstrate both directions, there should be a minimum of 5 s before control reversal to the opposite direction. <strong>CCA</strong>: Test in normal and non-normal control state.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
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<tr>
<td>2.b</td>
<td>(6) Small control inputs — yaw.</td>
<td>±0.15°/s body yaw rate or ±20% of peak body yaw rate applied throughout the time history.</td>
<td>Approach or landing.</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td>✔</td>
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</tbody>
</table>

Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0.5 to 2°/s yaw rate).

Test in both directions.

Show time history data from 5 s before until at least 5 s after initiation of control input.

If a single test is used to demonstrate both directions, there should be a minimum of 5 s before control reversal to the opposite direction.

CCA: Test in normal and non-normal control state.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
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<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.c</td>
<td>Longitudinal</td>
<td></td>
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</tr>
<tr>
<td>2.c</td>
<td>Power change dynamics.</td>
<td>±3 kt airspeed. ±30 m (100 ft) altitude. ±1.5° or ±20% of pitch angle.</td>
<td>Approach.</td>
<td>✓</td>
<td>C &amp; M</td>
<td>✓</td>
<td>C &amp; M</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note. — Power setting may be that required for level flight unless otherwise specified.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
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<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.c</td>
<td>(2) Flap change dynamics.</td>
<td>±3 kt airspeed.</td>
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<td></td>
<td>±30 m (100 ft) altitude.</td>
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<td></td>
<td></td>
<td>±1.5° or ±20% of pitch angle.</td>
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<tr>
<td></td>
<td>OR for type II and IV devices:</td>
<td>±2.2 daN (5 lbf) or ±20% of pitch controller force.</td>
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<tr>
<td></td>
<td>(2) Flap change force.</td>
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<tr>
<td>2.c</td>
<td>(3) Spoiler/ speedbrake change dynamics.</td>
<td>±3 kt airspeed.</td>
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<td></td>
<td></td>
<td>±30 m (100 ft) altitude.</td>
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<td></td>
<td></td>
<td>±1.5° or ±20% of pitch angle.</td>
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<tr>
<td></td>
<td>Cruise.</td>
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</table>

CCA: Test in normal and non-normal control mode for type V and VII devices. For type I, II, III, IV and VI devices test in normal mode only.

Force tests (type II or IV devices) should provide the force required to maintain constant airspeed or altitude to complete the configuration change.

Results required for both extension and retraction.

CCA: Test in normal and non-normal control mode for type V and VII devices. For type I, II, III, IV and VI devices, test in normal mode only.

Time history of uncontrolled free response for a time increment equal to at least 5 s before initiation of the configuration change to the completion of the configuration change +15 s.

Results required for both extension and retraction.

CCA: Test in normal and non-normal control mode for type V and VII devices. For type I, II, III, IV and VI devices, test in normal mode only.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
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<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.c</td>
<td>(4) Gear change dynamics.</td>
<td>±3 kt airspeed. &lt;br&gt;±30 m (100 ft) altitude. &lt;br&gt;±1.5° or ±20% of pitch angle.</td>
<td>Take-off (retraction) and approach (extension).</td>
<td>✓</td>
<td>C &amp; M</td>
<td>✓</td>
<td>C &amp; M</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>OR for type II and IV devices: (4) Gear change force.</td>
<td>±2.2 daN (5 lbf) or ±20% of pitch controller force.</td>
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<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
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<tr>
<td>2.c</td>
<td>(5) Longitudinal trim.</td>
<td>±1° elevator angle.</td>
<td>Cruise, approach and landing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Steady-state wings level trim with thrust for level flight. This test may be a series of snapshot tests.</td>
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<td></td>
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<td>±0.5° stabilizer angle.</td>
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<td></td>
<td>CCA: Test in normal or non-normal control mode, as applicable.</td>
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<td>±1° pitch angle.</td>
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<td></td>
<td>Types I, III &amp; VI may use pitch controller position instead of elevator angle and trim control position instead of stabilizer angle.</td>
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<tr>
<td></td>
<td></td>
<td>±5% of net thrust or equivalent.</td>
<td>For type I, III and VI devices:</td>
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<td>±2° elevator angle.</td>
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<td>±1° stabilizer angle.</td>
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<td></td>
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<td>±2° pitch angle.</td>
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<td></td>
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<td>±5% of net thrust or equivalent.</td>
<td>For type II and IV devices:</td>
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<td></td>
<td></td>
<td>±2° elevator angle.</td>
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<td></td>
<td>±1° stabilizer angle.</td>
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<td></td>
<td></td>
<td>±2° pitch angle.</td>
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<td></td>
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<td>±5% of net thrust or equivalent.</td>
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<tr>
<td>2.c</td>
<td>(6) Longitudinal manoeuvring stability (stick force/g).</td>
<td>Cruise, approach and landing.</td>
<td>✓ PPL C</td>
<td>C T &amp; M</td>
<td>✓ C T &amp; M</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td></td>
<td>±2.2 daN (5 lbf) or ±10% of pitch controller force.</td>
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<td></td>
<td>Alternative method:</td>
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<td></td>
<td>±1° or ±10% of the change of elevator angle.</td>
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</table>

**COMMENTS**

- Continuous time history data or a series of snapshot tests may be used.
- Test up to approximately 30° of roll angle for approach and landing configurations. Test up to approximately 45° of roll angle for the cruise configuration.
- Force tolerance not applicable if forces are generated solely by the use of aeroplane hardware in the FSTD.
- Alternative method applies to aeroplanes which do not exhibit stick-force-per-g characteristics.
- For the Alternative method, Types I, III & VI may use pitch controller position instead of elevator angle.
- **CCA:** Test in normal and non-normal control mode for type V and VII devices. For type I, II, III, IV and VI devices, test in normal mode only.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
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<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.c</td>
<td>(7) Longitudinal static stability.</td>
<td>Approach.</td>
<td>✓</td>
<td>C</td>
<td>✓</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Data for at least two speeds above and two speeds below trim speed. The speed range should be sufficient to demonstrate stick force versus speed characteristics. This test may be a series of snapshot tests. Force tolerance is not applicable if forces are generated solely by the use of aeroplane hardware in the FSTD. Alternative method applies to aeroplanes which do not exhibit speed stability characteristics. For the alternative method, Types I, III &amp; VI may use pitch controller position instead of elevator angle. CCA: Test in normal or non-normal control mode, as applicable.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
<td>Type III</td>
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<tr>
<td>2.c</td>
<td>(8) Stall characteristics.</td>
<td>±3 kt airspeed for initial buffet, stall warning, and stall speeds. ±2° roll angle for speeds greater than stick shaker or initial buffet. For aeroplanes with reversible flight control systems: ±10% or ±2.2 daN (5 lbf) column force (prior to g-break only).</td>
<td>2nd segment climb and approach or landing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Wings-level (1 g) stall entry with thrust at or near idle power. Time history data should be shown to include full stall and initiation of recovery. Stall warning signal should be recorded and should occur in the proper relation to stall. FSTDs for aeroplanes exhibiting a sudden pitch attitude change or “g-break” should demonstrate this characteristic. CCA: Test in normal and non-normal control mode for type V and VII devices, as applicable. For type I, II, III, IV and VI devices test in normal mode only, if applicable.</td>
</tr>
<tr>
<td>2.c</td>
<td>(9) Phugoid dynamics.</td>
<td>±10% of period. ±10% of time to one half or double amplitude or ±0.02 of damping ratio. For type I, II, III, IV and VI devices: ±10% of period, with representative damping.</td>
<td>Cruise.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Test should include three full cycles or that necessary to determine time to one half or double amplitude, whichever is less. CCA: Test in non-normal control mode.</td>
</tr>
<tr>
<td>2.c</td>
<td>(10) Short period dynamics.</td>
<td>±1.5° pitch angle or ±2°/s pitch rate. ±0.1 g normal acceleration.</td>
<td>Cruise.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>CCA: Test in normal and non-normal control mode.</td>
</tr>
</tbody>
</table>
## TEST TOLERANCE FLIGHT CONDITION

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.d</td>
<td>Lateral directional</td>
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<tr>
<td>2.d (1)</td>
<td>Minimum control speed, air ( (V_{mca}) ) or landing ( (V_{mcl}) ), per applicable airworthiness requirement or low speed engine-inoperative handling characteristics in the air.</td>
<td>±3 kt airspeed.</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>✓</td>
<td>C</td>
<td>✓</td>
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<td></td>
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<td>Take-off or landing (whichever is most critical in the aeroplane).</td>
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</table>

Note. — Power setting may be that required for level flight unless otherwise specified.

Minimum speed may be defined by a performance or control limit which prevents demonstration of \( V_{mca} \) or \( V_{mcl} \) in the conventional manner.

Take-off thrust should be set on the operating engine(s).

Time history or snapshot data may be used.

For type I, II, III, IV and VI devices it is important that there exists a realistic speed relationship between \( V_{mca} \) (or \( V_{mcl} \)) and \( V_s \) for all configurations and in particular the most critical full-power engine-out configuration.

CCA: Test in normal or non-normal control state, as applicable.
<table>
<thead>
<tr>
<th>TEST</th>
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<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.d</td>
<td>(2) Roll response (rate).</td>
<td>±2°/s or ±10% of roll rate.</td>
<td>Cruise and approach or landing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td><strong>Test with normal roll control displacement (approximately one-third of maximum roll controller travel).</strong>&lt;br&gt;This test may be combined with step input of flight deck roll controller test 2.d.3.</td>
</tr>
<tr>
<td></td>
<td>For aeroplanes with reversible flight control systems:</td>
<td>±1.3 daN (3 lbf) or ±10% of wheel force.</td>
<td>PPL CPL CT &amp; M MPL1</td>
<td>C T &amp; M</td>
<td>C T &amp; M</td>
<td>C T &amp; M</td>
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</tr>
<tr>
<td>2.d</td>
<td>(3) Step input of flight deck roll controller.</td>
<td>±2° or ±10% of roll angle.</td>
<td>Approach or landing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td><strong>With wings level, apply a step roll control input using approximately one-third of maximum roll controller travel. At approximately 20° to 30° roll angle, abruptly return the roll controller to neutral and allow at least 10 s of aeroplane free response.</strong>&lt;br&gt;This test may be combined with roll response (rate) test 2.d.2.</td>
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<td></td>
<td><strong>CCA:</strong> Test in normal and non-normal control mode for type V and VII devices. For type I, III and VI devices, test in normal mode only.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
<td>Type III</td>
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<td>Type VII</td>
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<tr>
<td>2.d</td>
<td>(4) Spiral stability.</td>
<td>Cruise and approach or landing.</td>
<td>✔️</td>
<td>✔️ C &amp; T</td>
<td>✔️ C &amp; T</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>2.d</td>
<td>(5) Engine-inoperative trim.</td>
<td>2nd segment climb and approach or landing.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<td>TEST</td>
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<tr>
<td>2.d (6)</td>
<td>Rudder response. ±2°/s or ±10% of yaw rate. <strong>Or</strong> for type II and IV devices: ±2°/s or ±10% of yaw rate or ±10% of heading change.</td>
<td>Approach or landing.</td>
<td>✓</td>
<td>C T &amp; M</td>
<td>✓</td>
<td>C T &amp; M</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Test with stability augmentation on and off. Test with a step input at approximately 25% of full rudder pedal throw. <strong>CCA:</strong> Test in normal and non-normal control mode for type V and VII devices. For type I, II, III, IV and VI devices, test in normal mode only.</td>
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<tr>
<td>2.d (7)</td>
<td>Dutch roll. ±0.5 s or ±10% of period. ±10% of time to one half or double amplitude or ±0.02 of damping ratio. ±1 s or ±20% of time difference between peaks of roll angle and side-slip angle. For type I, III and VI devices: ±0.5 s or ±10% of period, with representative damping.</td>
<td>Cruise and approach or landing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Test for at least six cycles with stability augmentation off. <strong>CCA:</strong> Test in non-normal control mode.</td>
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<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<tr>
<td>2.d</td>
<td>(8) Steady state side-slip.</td>
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<td>✓</td>
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<td>C</td>
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<td>For a given rudder position:</td>
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<td>±2° roll angle;</td>
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<td></td>
<td>±1° side-slip angle;</td>
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<td>±2° or ±10% of aileron angle;</td>
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<td></td>
<td>±5° or ±10% of spoiler or equivalent roll controller position or force.</td>
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<td></td>
<td>For aeroplanes with reversible flight control systems:</td>
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<td>✓</td>
<td>C</td>
<td>✓</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
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<td></td>
<td>±1.3 daN (3 lbf) or ±10% of wheel force.</td>
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<td></td>
<td>±2.2 daN (5 lbf) or ±10% of rudder pedal force.</td>
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<td></td>
<td>For Type I, III &amp; VI: Roll controller position instead of aileron angle</td>
<td></td>
<td>✓</td>
<td>C</td>
<td>✓</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td></td>
<td>may be used. Side-slip angle is matched only for repeatability and only on</td>
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<td></td>
<td>continuing recurrent evaluations.</td>
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<td>This test may be a series of snapshot tests using at least two rudder</td>
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<td>positions (in each direction for propeller-driven aeroplanes), one of</td>
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<td>which should be near maximum allowable rudder.</td>
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<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
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<td>Type VII</td>
<td>COMMENTS</td>
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<tr>
<td>2.e</td>
<td>Landings</td>
<td>±3 kt airspeed.</td>
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<td>±1.5° pitch angle.</td>
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<td>±1.5° AOA.</td>
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<td>±3 m (10 ft) or ±10% of height.</td>
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<td>For aeroplanes with reversible flight control systems:</td>
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<td>±2.2 daN (5 lb) or ±10% of column force.</td>
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<tr>
<td>2.e</td>
<td>(1) Normal landing.</td>
<td>Landing.</td>
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<td>✔</td>
<td>✔</td>
<td>Test from a minimum of 61 m (200 ft) AGL to nosewheel touchdown. Two tests should be shown, including two normal landing flaps (if applicable) one of which should be near maximum certificated landing mass, the other at light or medium mass.</td>
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<tr>
<td></td>
<td></td>
<td>Minimum certificated landing flap configuration.</td>
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<td>✔</td>
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<td>CCA: Test in normal and non-normal control mode, if applicable.</td>
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<tr>
<td>2.e</td>
<td>(2) Minimum flap landing.</td>
<td>Minimum certificated landing flap configuration.</td>
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<td>✔</td>
<td>✔</td>
<td>Test from a minimum of 61 m (200 ft) AGL to nosewheel touchdown. Test at near maximum certificated landing mass.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
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<tr>
<td>2.e</td>
<td>(3) Crosswind landing.</td>
<td>±3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA. ±3 m (10 ft) or ±10% of height. ±2° roll angle. ±2° side-slip angle. ±3° heading angle. For aeroplanes with reversible flight control systems: ±2.2 daN (5 lbf) or ±10% of column force. ±1.3 daN (3 lbf) or ±10% of wheel force. ±2.2 daN (5 lbf) or ±10% of rudder pedal force.</td>
<td>Landing.</td>
<td>✔</td>
<td>✔</td>
<td>Test from a minimum of 61 m (200 ft) AGL to a 50% decrease in main landing gear touchdown speed. It requires test data, including wind profile, for a crosswind component of at least 60% of aeroplane performance data value measured at 10 m (33 ft) above the runway. Wind components should be provided as headwind and crosswind values with respect to the runway.</td>
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<tr>
<td>2.e</td>
<td>(4) One-engine-inoperative landing.</td>
<td>±3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA. ±3 m (10 ft) or ±10% of height. ±2° roll angle. ±2° side-slip angle. ±3° heading angle.</td>
<td>Landing.</td>
<td>✔</td>
<td>✔</td>
<td>Test from a minimum of 61 m (200 ft) AGL to a 50% decrease in main landing gear touchdown speed.</td>
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<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<tr>
<td>2.e</td>
<td>*(5) Autopilot landing (if applicable).</td>
<td>±1.5 m (5 ft) flare height.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>If autopilot provides roll-out guidance, record lateral deviation from touchdown to a 50% decrease in main landing gear touchdown speed. Time of autopilot flare mode engage and main gear touchdown should be noted. Tf = duration of flare.</td>
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<td></td>
<td>±0.5 s or ± 10% of Tf.</td>
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<td></td>
<td>±0.7 m/s (140 ft/min) rate of descent at touchdown.</td>
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<td>±3 m (10 ft) lateral deviation during roll-out.</td>
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<tr>
<td>2.e</td>
<td>*(6) All-engine autopilot go-around.</td>
<td>±3 kt airspeed.</td>
<td>As per aeroplane performance data.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Normal all-engine autopilot go-around should be demonstrated (if applicable) at medium mass.</td>
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<td>±1.5° pitch angle.</td>
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<td>±1.5° AOA.</td>
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<tr>
<td>2.e</td>
<td>*(7) One-engine-inoperative go-around.</td>
<td>±3 kt airspeed.</td>
<td>As per aeroplane performance data.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Engine inoperative go-around required near maximum certificated landing mass with critical engine inoperative. Provide one test with autopilot (if applicable) and one without autopilot. CCA: Non-autopilot test to be conducted in non-normal mode.</td>
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<td></td>
<td>±1.5° pitch angle.</td>
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<td></td>
<td>±1.5° AOA.</td>
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<td></td>
<td>±2° roll angle.</td>
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<tr>
<td></td>
<td>±2° side-slip angle.</td>
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<tr>
<td>2.e</td>
<td>*(8) Directional control (rudder effectiveness) with reverse thrust (symmetric).</td>
<td>±5 kt airspeed.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Apply rudder pedal input in both directions using full reverse thrust until reaching full thrust reverser minimum operating speed.</td>
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<tr>
<td></td>
<td>±2°/s yaw rate.</td>
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<tr>
<td>2.e</td>
<td>(9) Directional control (rudder effectiveness) with reverse thrust (asymmetric).</td>
<td>±5 kt airspeed. ±3° heading angle.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>With full reverse thrust on the operating engine(s), maintain heading with rudder pedal input until maximum rudder pedal input or thrust reverser minimum operation speed is reached.</td>
<td></td>
</tr>
<tr>
<td>2.f</td>
<td>Ground effect</td>
<td>±1° elevator angle. ±0.5° stabilizer angle. ±5% of net thrust or equivalent. ±1° AOA. ±1.5 m (5 ft) or ±10% of height. ±3 kt airspeed. ±1° pitch angle.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>See paragraph 3.3.2 of this Appendix. A rationale should be provided with justification of results. CCA: Test in normal or non-normal control mode, as applicable.</td>
<td></td>
</tr>
<tr>
<td>2.g</td>
<td>Wind Shear</td>
<td>None.</td>
<td>Take-off and landing.</td>
<td>✓</td>
<td>✓</td>
<td>See Appendix A, requirement 11.2.</td>
<td></td>
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<tr>
<td>2.h</td>
<td>Flight and manoeuvre envelope protection functions</td>
<td>±5 kt airspeed.</td>
<td>Cruise.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>Note. — The requirements of 2.h are only applicable to computer-controlled aeroplanes. Time history results of response to control inputs during entry into each envelope protection function (i.e. with normal and degraded control states if their function is different) are required. Set thrust as required to reach the envelope protection function.</td>
</tr>
<tr>
<td>2.h</td>
<td>(1) Overspeed.</td>
<td>±5 kt airspeed.</td>
<td>Cruise.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
</tr>
<tr>
<td>2.h</td>
<td>(2) Minimum speed.</td>
<td>±3 kt airspeed.</td>
<td>Take-off, cruise and approach or landing.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
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</tr>
<tr>
<td>2.h</td>
<td>(3) Load factor.</td>
<td>±0.1 g normal acceleration.</td>
<td>Take-off, cruise.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
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</tr>
<tr>
<td>2.h</td>
<td>(4) Pitch angle.</td>
<td>±1.5° pitch angle.</td>
<td>Cruise, approach.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>2.h</td>
<td>(5) Roll angle.</td>
<td>±2° or ±10% of roll angle.</td>
<td>Approach.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
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</tr>
<tr>
<td>2.h</td>
<td>(6) Angle of attack.</td>
<td>±1.5° AOA.</td>
<td>2nd segment and approach or landing.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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</table>
### Part II. Flight Simulation Training Device Criteria

#### Appendix B 
FSTD validation tests

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
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<tbody>
<tr>
<td>3. MOTION SYSTEM</td>
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<tr>
<td>3.a Frequency response.</td>
<td>As specified by the applicant for FSTD qualification.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>Appropriate test to demonstrate required frequency response. See also paragraph 3.5.2 of this Appendix.</td>
</tr>
<tr>
<td>Leg Balance.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>✔</td>
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</tr>
<tr>
<td>3.b Turn-around check.</td>
<td>As specified by the applicant for FSTD qualification.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>Appropriate test to demonstrate required smooth turn-around. See also paragraph 3.5.2 of this Appendix.</td>
</tr>
<tr>
<td>3.c Motion effects.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>Refer to Appendix C of this Part on subjective testing.</td>
</tr>
<tr>
<td>3.d Motion system repeatability.</td>
<td>±0.05 g actual platform linear accelerations.</td>
<td>None.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>Ensure that 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 3.5.4 of this Appendix.</td>
</tr>
<tr>
<td>TEST</td>
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<tr>
<td>3.e</td>
<td>(1) Motion cueing fidelity – Frequency-domain criterion.</td>
<td>TBD.</td>
<td>Ground and flight.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>3.e</td>
<td>(2) Motion cueing fidelity – Time-domain criterion</td>
<td>TBD.</td>
<td>Ground and flight.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Appropriate testing criterion and tolerances are currently being tested and evaluated through the ICFQ mechanism (refer to Appendix D of this Part).</td>
</tr>
<tr>
<td>3.f</td>
<td>Characteristic motion vibrations. The following tests with recorded results and an SOC are required for characteristic motion vibrations, which can be sensed at the flight deck where applicable by aeroplane type.</td>
<td>None.</td>
<td>Ground and flight.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>The recorded test results for characteristic buffets should allow the comparison of relative amplitude versus frequency. See also paragraph 3.5.5 of this Appendix. For type VI devices footprint test results are required.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
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<tr>
<td>3.f.</td>
<td>(1) Thrust effects with brakes set.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data.</td>
<td>Ground.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>Test should be conducted at maximum possible thrust with brakes set.</td>
</tr>
<tr>
<td>3.f.</td>
<td>(2) Landing gear extended buffet.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data.</td>
<td>Flight.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>Test condition should be for a normal operational speed and not at the gear limiting speed.</td>
</tr>
<tr>
<td>3.f.</td>
<td>(3) Flaps extended buffet.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data.</td>
<td>Flight.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>Test condition should be at a normal operational speed and not at the flap limiting speed.</td>
</tr>
<tr>
<td>3.f.</td>
<td>(4) Speedbrake deployed buffet.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data.</td>
<td>Flight.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>Test condition should be at a typical speed for a representative buffet.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
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<tr>
<td>3.f.</td>
<td>(5) Approach to stall buffet.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data.</td>
<td>Flight.</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Test condition should be at approach to stall. Post-stall characteristics are not required.</td>
</tr>
<tr>
<td>3.f.</td>
<td>(6) High speed or Mach buffet.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data.</td>
<td>Flight.</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Test condition should be for high-speed manoeuvre buffet/wind-up-turn or alternatively Mach buffet.</td>
</tr>
<tr>
<td>3.f.</td>
<td>(7) In-flight vibrations.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data.</td>
<td>Flight in clean configuration.</td>
<td>✔️</td>
<td>✔️</td>
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<td></td>
<td>Test should be conducted to be representative of in-flight vibrations for propeller-driven aeroplanes.</td>
</tr>
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</table>
## TEST

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<tr>
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<td>4.</td>
<td>VISUAL SYSTEM</td>
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<tr>
<td>4.a</td>
<td>Visual scene quality</td>
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<tr>
<td>4.a.1</td>
<td>Continuous collimated cross-cockpit visual field of view.</td>
<td>Cross-cockpit, collimated visual display providing each pilot with a minimum of 200° horizontal and 40° vertical continuous field of view.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>Field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5° squares. Installed alignment should be confirmed in an SOC (this would generally consist of results from acceptance testing).</td>
</tr>
<tr>
<td></td>
<td>Continuous cross-cockpit visual field of view.</td>
<td>Visual display providing each pilot with a minimum of 200° horizontal and 40° vertical continuous field of view.</td>
<td>Not applicable.</td>
<td>✓ PPL CPL</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5° squares. Installed alignment should be confirmed in an SOC (this would generally consist of results from acceptance testing).</td>
</tr>
<tr>
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<tr>
<td>4.a.1 (ctd)</td>
<td>Display field of view.</td>
<td>Visual field-of-view for each pilot with a minimum of 45° horizontally and 30° vertically, unless restricted by the type of aeroplane, simultaneously for each pilot.</td>
<td>Not applicable.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>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. 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.</td>
</tr>
<tr>
<td>4.a.2.a.1</td>
<td>System geometry – Image position.</td>
<td>From each eyepoint position the centre of the image is between 0° and 2° inboard in the horizontal plane and within +/-0.25° vertically. The difference between the left and right horizontal angles should not exceed 1°.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>4.a.2.a.2</td>
<td>System geometry – Absolute geometry.</td>
<td>Within the central 200° x 40°, all points on a 5-degree grid should fall within 3° of the design position as measured from each pilot eyepoint.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>Where a system with more than 200° x 40° is supplied, the geometry outside the central area should not have any distracting discontinuities.</td>
<td></td>
</tr>
<tr>
<td>TEST</td>
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<tr>
<td>4.a.2.a.3</td>
<td>System geometry – Relative geometry.</td>
<td>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 90° degrees 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: Zone 1: 0.075°/degree; Zone 2: 0.15°/degree; Zone 3: 0.2°/degree.</td>
<td>Not applicable.</td>
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<td>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.</td>
</tr>
<tr>
<td>4.a.2.b</td>
<td>Geometry of image should have no distracting discontinuities.</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>4.a.3</td>
<td>Surface resolution (object detection).</td>
<td>Not greater than 2 arc minutes.</td>
<td>Not applicable.</td>
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<td>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.</td>
</tr>
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<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<tr>
<td>4.a.3 (ctd)</td>
<td>Surface resolution (object detection).</td>
<td>Not greater than 4 arc minutes.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>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.</td>
</tr>
<tr>
<td>4.a.4</td>
<td>Light point size.</td>
<td>Not greater than 5 arc minutes.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Light point size should be measured using a test pattern consisting of a centrally located single row of white 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.</td>
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<td>TEST</td>
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<tr>
<td>4.a.4 (ctd)</td>
<td>Light point size.</td>
<td>Not greater than 8 arc minutes.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Light point size should be measured using a test pattern consisting of a centrally located single row of white 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.</td>
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<tr>
<td>4.a.5</td>
<td>Raster surface contrast ratio.</td>
<td>Not less than 5:1.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Surface contrast ratio should be measured using a raster drawn test pattern filling the entire visual scene (all channels). The test pattern should consist of black and white squares, 5° per square, with a white square in the centre of each channel. Measurement should be made on the centre bright square for each channel using a 1° spot photometer. This value should have a minimum brightness of 7 cd/m² (2 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-cab and flight deck 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.</td>
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<td>TEST</td>
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<tr>
<td>4.a.6</td>
<td>Light point contrast ratio.</td>
<td>Not less than 25:1.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>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 discernible 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-cab and flight deck ambient light levels should be as low as practical.</td>
<td>Comments as above.</td>
</tr>
<tr>
<td>Light point contrast ratio.</td>
<td>Not less than 10:1.</td>
<td>Not applicable.</td>
<td>✓</td>
<td></td>
<td>✓</td>
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<td>4.a.7</td>
<td>Light point brightness.</td>
<td>Not less than 30 cd/m² (8.8 ft-lamberts).</td>
<td>Not applicable.</td>
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<td></td>
<td>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).</td>
</tr>
<tr>
<td></td>
<td>Light point brightness.</td>
<td>Not less than 20 cd/m² (5.8 ft-lamberts).</td>
<td>Not applicable.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>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).</td>
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<tr>
<td>4.a.8 Surface brightness.</td>
<td>Not less than 20 cd/m² (5.8 ft-lamberts) on the display.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>Surface brightness should be measured on a white raster, measuring the brightness using the 1° spot photometer. Light points are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable.</td>
</tr>
<tr>
<td>Surface brightness.</td>
<td>Not less than 14 cd/m² (4.1 ft-lamberts) on the display.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>PPL</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>PPL</td>
<td>Surface brightness should be measured on a white raster, measuring the brightness using the 1° spot photometer. Light points are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable.</td>
</tr>
<tr>
<td>TEST</td>
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<td>FLIGHT CONDITION</td>
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<tr>
<td>4.a.9</td>
<td>Black level and sequential contrast.</td>
<td>Black intensity: Background brightness – Black polygon brightness &lt; 0.015 cd/m² (0.004 ft-lamberts). Sequential contrast: Maximum brightness – (Background brightness – Black polygon brightness) &gt; 2 000:1.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>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 background 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.</td>
</tr>
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<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<tr>
<td>4.a.10</td>
<td>Motion blur.</td>
<td>When a pattern is rotated about the eyepoint at 10°/s, the smallest detectable gap should be 4 arc min or less.</td>
<td>Not applicable.</td>
<td></td>
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<td></td>
<td>A test pattern consists of an array of 5 peak white squares with black gaps between them of decreasing width.</td>
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<td>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.</td>
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<td></td>
<td>The pattern is rotated at the required rate.</td>
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<td></td>
<td>Two arrays of squares should be provided, one rotating in heading and the other in pitch, to provide testing in both axes.</td>
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<td>A series of stationary numbers identifies the gap number.</td>
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<td>Note — This test can be limited by the display technology. Where this is the case the NAA should be consulted on the limitations.</td>
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<td></td>
<td>This test is generally only required for light valve projectors.</td>
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<td></td>
<td>An SOC should be provided if the test is not run, stating why.</td>
</tr>
<tr>
<td>TEST</td>
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<tr>
<td>4.a.11</td>
<td>Speckle test. Speckle contrast should be &lt; 10%.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>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.</td>
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<tr>
<td>4.b</td>
<td>Head-Up Display (HUD)</td>
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<tr>
<td>4.b.1</td>
<td>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.</td>
<td></td>
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<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Alignment requirement applies to any HUD system in use or both simultaneously if they are used simultaneously for training.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td></td>
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<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Alignment requirement only applies to the pilot flying.</td>
</tr>
<tr>
<td>4.b.2</td>
<td>System display. All functionality in all flight modes should be demonstrated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>A statement of the system capabilities should be provided and the capabilities demonstrated.</td>
</tr>
<tr>
<td>4.b.3</td>
<td>HUD attitude versus FSTD attitude indicator (pitch and roll of horizon). Pitch and roll align with aircraft instruments. Flight.</td>
<td></td>
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<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>For type III and V: Alignment requirement only applies to the pilot flying.</td>
</tr>
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<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<td>4.c</td>
<td>Enhanced Flight Vision System (EFVS)</td>
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<tr>
<td>4.c.1 Registration test.</td>
<td>Alignment between EFVS display and out of the window image should represent the alignment typical of the aircraft and system type.</td>
<td>Take-off point and on approach at 200 ft.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Note.— The effects of the alignment tolerance in 4.b.1 should be taken into account.</td>
<td></td>
</tr>
<tr>
<td>Registration test.</td>
<td>Alignment between EFVS display and out of the window image should represent the alignment typical of the aircraft and system type.</td>
<td>Take-off point and on approach at 200 ft.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Alignment requirement only applies to the pilot flying.</td>
<td>Note.— The effects of the alignment tolerance in 4.b.1 should be taken into account.</td>
<td></td>
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<tr>
<td>4.c.2 EFVS RVR and visibility calibration.</td>
<td>The scene represents the EFVS view at 350 m (1200 ft) and 1609 m (1 sm) RVR including correct light intensity.</td>
<td>Flight.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Infra-red scene representative of both 350 m (1 200 ft), and 1 609 m (1 sm) RVR. Visual scene may be removed.</td>
<td></td>
</tr>
<tr>
<td>4.c.3 Thermal crossover.</td>
<td>Demonstrate thermal crossover effects during day to night transition.</td>
<td>Day and night.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>The scene will correctly represent the thermal characteristics of the scene during a day to night transition.</td>
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<td>TEST</td>
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<td>FLIGHT CONDITION</td>
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<tr>
<td>4.d</td>
<td>Visual ground segment</td>
<td>Near end: the correct number of approach lights within the computed VGS should be visible. Far end: ±20% of the computed VGS. The threshold lights computed to be visible should be visible in the FSTD.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>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 aeroplane’s operational envelope for a normal approach and landing; and 4) Radio altimeter. If a generic aeroplane is used as the basic model, a generic cut-off angle of 15° is assumed as an ideal. 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.</td>
</tr>
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<td>TEST</td>
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<td>4.e</td>
<td>Visual System Capacity</td>
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<tr>
<td>4.e.1</td>
<td>System capacity – Day mode.</td>
<td>Not less than: 10 000 visible textured surfaces, 6 000 light points, 16 moving models.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>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.</td>
</tr>
<tr>
<td>4.e.2</td>
<td>System capacity – Twilight/night mode.</td>
<td>Not less than: 10 000 visible textured surfaces, 15 000 light points, 16 moving models.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>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.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
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<tr>
<td>4.e.3 System capacity – Reduced FOV visual systems.</td>
<td>Not less than: 3,500 visible textured surfaces, 5,000 light points, 16 moving models.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>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. Applies only to Type I FSTD when used to support MPL1 training, and to Type II FSTD when used to support IR training, both applications allowing the use of a reduced FOV visual system.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
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<td>5</td>
<td>SOUND SYSTEMS</td>
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<tr>
<td>5.a</td>
<td>Turbo-jet/Turbo-fan aeroplanes</td>
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All Type V to VII 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 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 IV, tests in this section may be presented as a single overall SPL level.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
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<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.a</td>
<td>(1) Ready for engine start.</td>
<td>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.</td>
<td>Ground.</td>
<td>✔</td>
<td>✔</td>
<td></td>
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<td></td>
<td>✔</td>
<td>Normal condition prior to engine start. The APU should be on if appropriate. For Type VII: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
<td></td>
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<td>✔</td>
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<td></td>
<td>Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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### Part II. Flight Simulation Training Device Criteria

#### Appendix B     FSTD validation tests II-App B-8

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<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>5.a</td>
<td>(2) All engines at idle.</td>
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<td>Initial evaluation: ±5 dB per 1/3 octave band.</td>
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<td>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.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>5.a</td>
<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td></td>
<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td>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.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<p>| Normal condition prior to take-off.                                                                 |
| For Type VII: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct. |
| For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations. |</p>
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<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.a</td>
<td>(3) All engines at maximum allowable thrust with brakes set.</td>
<td>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. Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
<td>Ground.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Normal condition prior to take-off. This test is intended to check the maximum stabilized allowable thrust with brakes set, without jeopardizing the aircraft and safety. For Type VII: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.</td>
</tr>
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<td>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.</td>
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<td>For Type VII: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct.</td>
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<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td>For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.</td>
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<td>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.</td>
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<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<tr>
<td>5.a</td>
<td>(5) Cruise.</td>
<td>Initial evaluation: ± 5 dB per 1/3 octave band. &lt;br&gt;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.</td>
<td>Cruise.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>Normal cruise configuration. &lt;br&gt;For Type VII: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. &lt;br&gt;For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.</td>
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<tr>
<td>TEST</td>
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<tr>
<td>5.a</td>
<td>(6) Speed brake/spoilers extended (as appropriate).</td>
<td>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.</td>
<td>Cruise.</td>
<td></td>
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<td>✓</td>
<td>Normal and constant speed brake deflection for descent at a constant airspeed and power setting. For Type VII: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct. For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.</td>
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<tr>
<td>5.a</td>
<td>(7) Initial approach.</td>
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<td>Constant airspeed, gear up, flaps/slats as appropriate.</td>
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<td>Initial evaluation: ±5 dB per 1/3 octave band.</td>
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<td>For Type VII: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct.</td>
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<td></td>
<td>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.</td>
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<td>For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.</td>
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<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td>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.</td>
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<td></td>
<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td></td>
<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>5.a</td>
<td>(8) Final approach.</td>
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<td>Initial evaluation: ± 5 dB per 1/3 octave band.</td>
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<td>Landing.</td>
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- Constant airspeed, gear down, landing configuration flaps.
- For Type VII: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct.
- For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
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<th>Type VI</th>
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<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.b</td>
<td>Propeller-driven aeroplanes</td>
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<td>All Type V to VII 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 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 IV, tests in this section may be presented as a single overall SPL level.</td>
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<td>TEST</td>
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<td>5.b</td>
<td>(1) Ready for engine start.</td>
<td>Initial evaluation: ±5 dB per 1/3 octave band.</td>
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<td>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.</td>
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<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>9.c</td>
<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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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.

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.

Normal condition prior to engine start. The APU should be on if appropriate.

For Type VII: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct.

For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>5.b</td>
<td>(2) All propellers feathered, if applicable.</td>
<td>Initial evaluation: ±5 dB per 1/3 octave band.</td>
<td>Ground.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Normal condition prior to take-off. For Type VII: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct. For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.</td>
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<td>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.</td>
<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td>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.</td>
<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
<td>✓</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>5.b</td>
<td>(3) Ground idle or equivalent.</td>
<td>Ground.</td>
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<td>✔</td>
<td>Normal condition prior to take-off.</td>
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<td>5.b</td>
<td>(4) Flight idle or equivalent.</td>
<td>Initial evaluation: ± 5 dB per 1/3 octave band.</td>
<td>Ground.</td>
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<td>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.</td>
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<td>Normal condition prior to take-off.</td>
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<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td>For Type VII: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct.</td>
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<td>For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.</td>
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<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td>5.b</td>
<td>(5) All engines at maximum allowable power with brakes set.</td>
<td>Initial evaluation: ± 5 dB per 1/3 octave band.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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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.

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.

Normal condition prior to take-off.

For Type VII: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct.

For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
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<td>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.</td>
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<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td>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.</td>
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<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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Medium altitude.

For Type VII: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct.

For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
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<tbody>
<tr>
<td>5.b</td>
<td>(7) Cruise</td>
<td>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. 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.</td>
<td>Cruise.</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Normal cruise configuration. For Type VII: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct. For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.</td>
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<td>5.b</td>
<td>5.b Initial approach.</td>
<td>Initial evaluation: ±5 dB per 1/3 octave band.</td>
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<td>Constant airspeed, gear up, flaps extended as appropriate, RPM as per operating manual.</td>
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<td>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.</td>
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<td>For Type VII: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct.</td>
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<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td>For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.</td>
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<td>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.</td>
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<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>5.b</td>
<td>(9) Final approach.</td>
<td>Initial evaluation: ± 5 dB per 1/3 octave band.</td>
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<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td>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.</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
|      |           | Landing. | ✔️ | ✔️ | | | | | | Constant airspeed, gear down, landing configuration flaps, RPM as per operating manual. For Type VII: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.c</td>
<td>Special cases (ctd next page)</td>
<td>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.</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>This applies to special steady-state cases identified as particularly significant to the pilot, important in training, or unique to a specific aeroplane type or model. For Type VII: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct. For Type VII: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations. All Type V to VII 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 at the location corresponding to the approved data set.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>Type I</td>
<td>Type II</td>
<td>Type III</td>
<td>Type IV</td>
<td>Type V</td>
<td>Type VI</td>
<td>Type VII</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>------</td>
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</tr>
</tbody>
</table>

5.d  FSTD background noise

| Initial evaluation: background noise levels should fall below the plot in Figure B-10 of this Appendix. |
| Recurrent evaluation: ±3 dB per 1/3 octave band compared to initial evaluation. |
| Initial evaluation: subjective assessment of measured overall SPL. |
| Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation. |

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 IV, tests in this section may be presented as a single overall SPL level.

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 V to VII, 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 IV, this test may be presented as a single overall SPL level.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.e</td>
<td>Frequency response</td>
<td>Initial evaluation: not applicable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>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 V to VII, 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 IV, this test should be run at three frequencies (high, mid-range, and low).</td>
</tr>
</tbody>
</table>

Recurrent evaluation: not applicable.

Recurrent evaluation: ±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.

Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.
<table>
<thead>
<tr>
<th></th>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>SYSTEMS INTEGRATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.a.   System response time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1) Transport delay.</td>
<td>100 milliseconds or less</td>
<td>Pitch, roll and yaw.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>after controller movement.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 milliseconds or less</td>
<td>after controller movement.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

One separate test is required in each axis.

Where EFVS systems are installed, the EFVS response should be within + or - 30 ms from visual system response, and not before motion system response.

*Note.*—The delay from the aeroplane EFVS electronic elements should be added to the 30 ms tolerance before comparison with visual system reference as described in Attachment G of this Part.
Appendix C

FUNCTIONS AND SUBJECTIVE TESTS

1. INTRODUCTION

1.1 Accurate replication of aeroplane systems functions should be checked at each flight crew member position. This includes procedures using the AFM and checklists. Handling qualities, performance and FSTD systems operation will 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 aeroplane. Unlike the objective tests listed in Appendix B, 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 or special emphasis items in the training programme. Unless directly related to a requirement for the current qualification level, 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. A useful source of guidance for conducting the functions and subjective tests is published in the RAeS Aeroplane Flight Simulator Evaluation Handbook, Volume II (see Chapter 2 of this Part, paragraph 2.3).

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

2.3 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 aeroplane related procedures, normally contained in a Quick Reference Handbook (QRH). Systems are listed separately under “any flight phase” to ensure appropriate attention to systems checks.
3. TABLE OF FUNCTIONS AND SUBJECTIVE TESTS

Note 1.— The "**" noted for several Type VII items indicates that the requirement for a more sophisticated Air Traffic Control (ATC) environment simulation system in accordance with Appendix A, Section 9, applies to all Type VII training, testing and checking with the exception of Re (T).

Note 2.— “Other” – means any other test, as applicable to the simulated aeroplane and as applicable to the FSTD type.

<table>
<thead>
<tr>
<th>Number</th>
<th>Functions and Subjective Tests</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td></td>
<td>Pre-flight.</td>
<td>II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>III</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IV</td>
</tr>
<tr>
<td>1</td>
<td>Preparation for flight.</td>
<td>V</td>
</tr>
<tr>
<td>1.a</td>
<td>Pre-flight.</td>
<td>VI</td>
</tr>
<tr>
<td>1.a.1</td>
<td>The flight deck design and functions are identical to that of the aeroplane simulated.</td>
<td>VII</td>
</tr>
<tr>
<td>1.a.2</td>
<td>The flight deck design and functions represent those of the simulated class of aeroplanes.</td>
<td></td>
</tr>
<tr>
<td>1.a.3</td>
<td>The flight deck design and functions are aeroplane-like and generic but recognizable as within a class of aeroplanes.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Surface operations (pre-flight).</td>
<td></td>
</tr>
<tr>
<td>2.a</td>
<td>Engine start.</td>
<td></td>
</tr>
<tr>
<td>2.a.1</td>
<td>Normal start.</td>
<td></td>
</tr>
<tr>
<td>2.a.2</td>
<td>Alternate start procedures.</td>
<td></td>
</tr>
<tr>
<td>2.a.3</td>
<td>Abnormal starts and shutdowns (hot start, hung start, tail pipe fire, etc.).</td>
<td></td>
</tr>
<tr>
<td>2.b</td>
<td>Taxi.</td>
<td></td>
</tr>
<tr>
<td>2.b.1</td>
<td>Pushback/powerback.</td>
<td></td>
</tr>
<tr>
<td>2.b.2</td>
<td>Thrust response.</td>
<td></td>
</tr>
<tr>
<td>2.b.3</td>
<td>Power lever friction.</td>
<td></td>
</tr>
<tr>
<td>2.b.4</td>
<td>Ground handling.</td>
<td></td>
</tr>
<tr>
<td>2.b.5</td>
<td>Nosewheel scuffing.</td>
<td></td>
</tr>
<tr>
<td>2.b.6</td>
<td>Taxi aids (e.g. taxi camera, moving map).</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>2.b.7</td>
<td>Low visibility (taxi route, signage, lighting, markings, etc).</td>
<td>III</td>
</tr>
<tr>
<td>2.c</td>
<td><strong>Brake operation:</strong></td>
<td>IV</td>
</tr>
<tr>
<td>2.c.1</td>
<td>Normal, automatic and alternate/emergency operation.</td>
<td>V</td>
</tr>
<tr>
<td>2.c.2</td>
<td>Brake fade.</td>
<td>VI</td>
</tr>
<tr>
<td>2.d</td>
<td>Other.</td>
<td>VII</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Take-off.</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>Note.</strong>— Only those take-off tests relevant to the simulated aeroplane type or class should be selected from the following list, where tests should be made with limiting wind velocities, wind shear and with relevant system failures.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.a</td>
<td><strong>Normal.</strong></td>
<td></td>
</tr>
<tr>
<td>3.a.1</td>
<td>Aeroplane/engine parameter relationships, including run-up.</td>
<td></td>
</tr>
<tr>
<td>3.a.2</td>
<td>Nosewheel and rudder steering.</td>
<td></td>
</tr>
<tr>
<td>3.a.3</td>
<td>Crosswind (maximum demonstrated).</td>
<td></td>
</tr>
<tr>
<td>3.a.4</td>
<td>Special performance:</td>
<td></td>
</tr>
<tr>
<td>3.a.4.a</td>
<td>Reduced $V_1$.</td>
<td></td>
</tr>
<tr>
<td>3.a.4.b</td>
<td>Maximum engine de-rate.</td>
<td></td>
</tr>
<tr>
<td>3.a.4.c</td>
<td>Soft surface.</td>
<td></td>
</tr>
<tr>
<td>3.a.4.d</td>
<td>Short field/short take-off and landing (STOL) operations.</td>
<td></td>
</tr>
<tr>
<td>3.a.4.e</td>
<td>Obstacle (performance over visual obstacle).</td>
<td></td>
</tr>
<tr>
<td>3.a.5</td>
<td>Low visibility take-off.</td>
<td></td>
</tr>
<tr>
<td>3.a.6</td>
<td>Landing gear, wing flap and leading edge device operation.</td>
<td></td>
</tr>
<tr>
<td>3.a.7</td>
<td>Contaminated runway operations.</td>
<td></td>
</tr>
<tr>
<td>3.a.8</td>
<td>Other.</td>
<td></td>
</tr>
<tr>
<td>3.b</td>
<td><strong>Abnormal/emergency.</strong></td>
<td></td>
</tr>
<tr>
<td>3.b.1</td>
<td>Rejected take-off.</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>3.b.2</td>
<td>Rejected special performance take-off (e.g. reduced V1, maximum engine de-rate, soft field,</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>short field / short take-off and landing (STOL) operations, etc.)</td>
<td>✓</td>
</tr>
<tr>
<td>3.b.3</td>
<td>Rejected take-off with contaminated runway.</td>
<td>✓</td>
</tr>
<tr>
<td>3.b.4</td>
<td>Continued take-off with failure of most critical engine at most critical point.</td>
<td>✓</td>
</tr>
<tr>
<td>3.b.5</td>
<td>Flight control system failures, reconfiguration modes, manual reversion and associated</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>handling.</td>
<td>✓</td>
</tr>
<tr>
<td>3.b.6</td>
<td>Other.</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td><strong>Climb.</strong></td>
<td></td>
</tr>
<tr>
<td>4.a</td>
<td>Normal.</td>
<td>✓</td>
</tr>
<tr>
<td>4.b</td>
<td>One or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>4.c</td>
<td>Approach climb in icing (for aeroplanes with icing accountability).</td>
<td>✓</td>
</tr>
<tr>
<td>4.d</td>
<td>Other.</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td><strong>Cruise.</strong></td>
<td></td>
</tr>
<tr>
<td>5.a</td>
<td><strong>Performance characteristics (speed versus power, configuration, and attitude).</strong></td>
<td></td>
</tr>
<tr>
<td>5.a.1</td>
<td>Straight and level flight.</td>
<td>✓</td>
</tr>
<tr>
<td>5.a.2</td>
<td>Change of airspeed.</td>
<td>✓</td>
</tr>
<tr>
<td>5.a.3</td>
<td>High-altitude handling.</td>
<td>✓</td>
</tr>
<tr>
<td>5.a.4</td>
<td>High-Mach number handling (Mach tuck, Mach buffet) and recovery (trim change).</td>
<td>✓</td>
</tr>
<tr>
<td>5.a.5</td>
<td>Overspeed warning (in excess of $V_{mo}$ or $M_{mo}$).</td>
<td>✓</td>
</tr>
<tr>
<td>5.a.6</td>
<td>High-IAS handling.</td>
<td>✓</td>
</tr>
<tr>
<td>5.a.7</td>
<td>Other.</td>
<td>✓</td>
</tr>
<tr>
<td>5.b</td>
<td><strong>Manoeuvres.</strong></td>
<td></td>
</tr>
<tr>
<td>5.b.1</td>
<td>High angle of attack, approach to stalls, stall warning, buffet, and g-break (take-off, cruise,</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>approach, and landing configuration).</td>
<td>✓</td>
</tr>
<tr>
<td>5.b.2</td>
<td>Slow flight.</td>
<td>✓</td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>5.b.3</td>
<td>Spin.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.4</td>
<td>Flight envelope protection (high angle of attack, bank limit, overspeed, etc.).</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.5</td>
<td>Turns with/without speedbrake/spoilers deployed.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.6</td>
<td>Normal and standard rate turns.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.7</td>
<td>Steep turns.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.8</td>
<td>Performance turn.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.9</td>
<td>In-flight engine shutdown and restart (assisted and windmill).</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.10</td>
<td>Manoeuvring with one or more engines inoperative.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.11</td>
<td>Specific flight characteristics (e.g. direct lift control).</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.12</td>
<td>Flight control system failures, reconfiguration modes, manual reversion and associated handling.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.13</td>
<td>Gliding to a forced landing.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.14</td>
<td>Visual resolution and FSTD handling and performance for the following:</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.14.a</td>
<td>Terrain accuracy for forced landing area selection.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.14.c</td>
<td>Eights on pylons (visual resolution).</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.14.d</td>
<td>Turns about a point.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.14.e</td>
<td>S-turns about a road or section line.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>5.b.15</td>
<td>Other.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>6.</td>
<td>Descent.</td>
<td></td>
</tr>
<tr>
<td>6.a</td>
<td>Normal.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>6.b</td>
<td>Maximum rate/emergency (clean, with speedbrakes, etc.).</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>6.c</td>
<td>With autopilot.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>6.d</td>
<td>Flight control system failures, reconfiguration modes, manual reversion and associated handling.</td>
<td></td>
</tr>
<tr>
<td>6.e</td>
<td>Other.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Instrument approaches and landing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Note.</strong> Only those instrument approach and landing tests relevant to the simulated aeroplane type or class should be selected from the following list, where tests should be made with limiting wind velocities, wind shear (except for the CAT II and III precision approaches) and with relevant system failures.</td>
<td></td>
</tr>
<tr>
<td>7.a</td>
<td>Precision approach.</td>
<td></td>
</tr>
<tr>
<td>7.a.1</td>
<td>CAT I published approaches.</td>
<td></td>
</tr>
<tr>
<td>7.a.1.a</td>
<td>Manual approach with/without flight director including landing.</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.1.b</td>
<td>Autopilot/autothrottle coupled approach and manual landing.</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.1.c</td>
<td>Autopilot/autothrottle coupled approach, engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.1.d</td>
<td>Manual approach, engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.1.e</td>
<td>HUD/EFVS.</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.2</td>
<td>CAT II published approaches.</td>
<td></td>
</tr>
<tr>
<td>7.a.2.a</td>
<td>Autopilot/autothrottle coupled approach to DH and landing (manual and autoland).</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.2.b</td>
<td>Autopilot/autothrottle coupled approach with one-engine-inoperative approach to DH and go-around (manual and autopilot).</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.2.c</td>
<td>HUD/EFVS.</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.3</td>
<td>CAT III published approaches.</td>
<td></td>
</tr>
<tr>
<td>7.a.3.a</td>
<td>Autopilot/autothrottle coupled approach to landing and roll-out (if applicable) guidance (manual and autoland).</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.3.b</td>
<td>Autopilot/autothrottle coupled approach to DH and go-around (manual and autopilot).</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.3.c</td>
<td>Autopilot/autothrottle coupled approach to land and roll-out (if applicable) guidance with one engine inoperative (manual and autoland).</td>
<td>✓</td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------------------------------------------------------------------------</td>
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<tr>
<td></td>
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<td>I</td>
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<td>V</td>
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<td></td>
<td>VI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VII</td>
</tr>
<tr>
<td>7.a.3.d</td>
<td>Autopilot/autothrottle coupled approach to DH and go-around with one engine inoperative (manual and autopilot).</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.3.e</td>
<td>HUD/EFVS.</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.4</td>
<td>Autopilot/autothrottle coupled approach (to a landing or to a go-around):</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.4.a</td>
<td>With generator failure.</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.4.b</td>
<td>With maximum tail wind component certified or authorized.</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.4.c</td>
<td>With maximum crosswind component demonstrated or authorized.</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.5</td>
<td>PAR approach, all engine(s) operating and with one or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>7.a.6</td>
<td>MLS, GBAS, all engine(s) operating and with one or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>7.b</td>
<td>Non-precision approach.</td>
<td>✓</td>
</tr>
<tr>
<td>7.b.1</td>
<td>Surveillance radar approach, all engine(s) operating and with one or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>7.b.2</td>
<td>NDB approach, all engine(s) operating and with one or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>7.b.3</td>
<td>VOR, VOR/DME, TACAN approach, all engines(s) operating and with one or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>7.b.4</td>
<td>RNAV / RNP / GNSS (RNP at nominal and minimum authorized temperatures) approach, all engine(s) operating and with one or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>7.b.5</td>
<td>ILS LLZ (LOC), LLZ back course (or LOC-BC) approach, all engine(s) operating and with one or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>7.b.6</td>
<td>ILS offset localizer approach, all engine(s) operating and with one or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>7.c</td>
<td>Approach procedures with vertical guidance (APV), e.g. SBAS, flight path vector.</td>
<td>✓</td>
</tr>
<tr>
<td>7.c.1</td>
<td>APV/baro-VNAV approach, all engine(s) operating and with one or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>7.c.2</td>
<td>Area navigation (RNAV) approach procedures based on SBAS, all engine(s) operating and with one or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
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</tr>
<tr>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>8</td>
<td>Visual approaches (segment) and landings.</td>
<td>✓</td>
</tr>
<tr>
<td>8.a</td>
<td>Manoeuvring, normal approach and landing all engines operating, with and without visual and navigational approach aid guidance.</td>
<td>✓</td>
</tr>
<tr>
<td>8.b</td>
<td>Approach and landing with one or more engine(s) inoperative.</td>
<td>✓</td>
</tr>
<tr>
<td>8.c</td>
<td>Operation of landing gear, flap/slats and speedbrakes (normal and abnormal).</td>
<td>✓</td>
</tr>
<tr>
<td>8.d</td>
<td>Approach and landing with crosswind (maximum demonstrated crosswind component).</td>
<td>✓</td>
</tr>
<tr>
<td>8.e</td>
<td>Approach and landing with flight control system failures (for reconfiguration modes, manual reversion and associated handling with the most significant degradation which is probable).</td>
<td>✓</td>
</tr>
<tr>
<td>8.f</td>
<td>Approach and landing with standby (minimum) electrical/hydraulic power.</td>
<td>✓</td>
</tr>
<tr>
<td>8.g</td>
<td>Approach and landing from circling conditions (circling approach).</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note.— For Types III, V, VI and VII, this test requires as a minimum a representative airport scene that can provide a heading difference of 90°, or more, and 180°, or less, between approach and landing runways. Any associated hazard lights or any other visual aids for use as part of the published circling procedure should be included in the correct position(s) and be of the appropriate colour(s), directionality and behaviour. For Type II and Type IV, a generic airport model to be consistent with published data used for aeroplane operations may be used and should contain both the approach and landing runways and have the capability to light both at the same time. Any associated hazard lights or any other visual aids for use as part of the published circling procedure need to be included in the correct position(s) and be of the appropriate colour(s) and behaviour.

| 8.h    | Approach and landing from visual traffic pattern. | ✓    | ✓  | ✓   | ✓  | ✓  | ✓  | ✓   |
| 8.i    | Approach and landing from non-precision approach. | ✓    | ✓  | ✓   | ✓  | ✓  | ✓  | ✓   |
| 8.j    | Approach and landing from precision approach. | ✓    | ✓  | ✓   | ✓  | ✓  | ✓  | ✓   |
| 8.k    | Other. | ✓    | ✓  | ✓   | ✓  | ✓  | ✓  | ✓   |

Note.— An FSTD with a visual system, which permits completing a special approach procedure in accordance with applicable regulations, may be approved for that particular approach procedure.
<table>
<thead>
<tr>
<th>Number</th>
<th>Functions and Subjective Tests</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td><strong>Missed Approach.</strong></td>
<td></td>
</tr>
<tr>
<td>9.a</td>
<td>All engines, manual and autopilot.</td>
<td>✓</td>
</tr>
<tr>
<td>9.b</td>
<td>Engine(s) inoperative, manual and autopilot.</td>
<td>✓</td>
</tr>
<tr>
<td>9.c</td>
<td>Rejected landing.</td>
<td>✓</td>
</tr>
<tr>
<td>9.d</td>
<td>With auto-flight, flight control system failures, reconfiguration modes, and manual reversion.</td>
<td>✓</td>
</tr>
<tr>
<td>10</td>
<td><strong>Surface operations (landing, after-landing and post-flight).</strong></td>
<td></td>
</tr>
<tr>
<td>10.a</td>
<td><strong>Landing roll and taxi.</strong></td>
<td></td>
</tr>
<tr>
<td>10.a.1</td>
<td>HUD/EFVS.</td>
<td>✓</td>
</tr>
<tr>
<td>10.a.2</td>
<td>Spoiler operation.</td>
<td>✓</td>
</tr>
<tr>
<td>10.a.3</td>
<td>Reverse thrust operation.</td>
<td>✓</td>
</tr>
<tr>
<td>10.a.4</td>
<td>Directional control and ground handling, both with and without reverse thrust.</td>
<td>✓</td>
</tr>
<tr>
<td>10.a.5</td>
<td>Reduction of rudder effectiveness with increased reverse thrust (rear pod-mounted engines).</td>
<td>✓</td>
</tr>
<tr>
<td>10.a.6</td>
<td><strong>Brake and anti-skid operation:</strong></td>
<td></td>
</tr>
<tr>
<td>10.a.6.a</td>
<td>Brake and anti-skid operation with dry, wet, icy, patchy wet, patchy ice, wet on rubber residue in touchdown zone conditions.</td>
<td>✓</td>
</tr>
<tr>
<td>10.a.6.b</td>
<td>Brake and anti-skid operation with dry and wet conditions.</td>
<td>✓</td>
</tr>
<tr>
<td>10.a.6.c</td>
<td>Brake and anti-skid operation with dry conditions.</td>
<td>✓</td>
</tr>
<tr>
<td>10.a.6.d</td>
<td>Auto-braking system operation.</td>
<td>✓</td>
</tr>
<tr>
<td>10.a.7</td>
<td>Other.</td>
<td>✓</td>
</tr>
<tr>
<td>10.b</td>
<td><strong>Engine shutdown and parking.</strong></td>
<td></td>
</tr>
<tr>
<td>10.b.1</td>
<td>Engine and systems operation.</td>
<td>✓</td>
</tr>
<tr>
<td>10.b.2</td>
<td>Parking brake operation.</td>
<td>✓</td>
</tr>
<tr>
<td>10.b.3</td>
<td>Other.</td>
<td>✓</td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>11</td>
<td>Any flight phase.</td>
<td></td>
</tr>
<tr>
<td>11.a</td>
<td>Aeroplane and engine systems operation (where fitted).</td>
<td></td>
</tr>
<tr>
<td>11.a.1</td>
<td>Air conditioning and pressurisation (Environmental Control System).</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.2</td>
<td>De-icing/anti-icing.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.3</td>
<td>Auxiliary engine/auxiliary power unit (APU).</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.4</td>
<td>Communications.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.5</td>
<td>Electrical.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.6</td>
<td>Fire and smoke detection and suppression.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.7</td>
<td>Flight controls (primary and secondary).</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.8</td>
<td>Fuel and oil.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.9</td>
<td>Hydraulic.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.10</td>
<td>Pneumatic.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.11</td>
<td>Landing gear.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.12</td>
<td>Oxygen.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.13</td>
<td>Engine.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.14</td>
<td>Airborne radar.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.15</td>
<td>Autopilot and flight director.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.16</td>
<td>Terrain awareness warning systems and collision avoidance systems (e.g. EGPWS, GPWS, TCAS).</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.17</td>
<td>Flight control computers including stability and control augmentation.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.18</td>
<td>Flight display systems.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.19</td>
<td>Flight management systems.</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.20</td>
<td>Head-up displays (including EFVS, if appropriate).</td>
<td>✔</td>
</tr>
<tr>
<td>11.a.21</td>
<td>Navigation systems.</td>
<td>✔</td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>11.a.22</td>
<td>Stall warning/avoidance.</td>
<td></td>
</tr>
<tr>
<td>11.a.23</td>
<td>Wind shear avoidance/recovery guidance equipment.</td>
<td></td>
</tr>
<tr>
<td>11.a.24</td>
<td>Flight envelope protections.</td>
<td></td>
</tr>
<tr>
<td>11.a.25</td>
<td>Electronic flight bag.</td>
<td></td>
</tr>
<tr>
<td>11.a.26</td>
<td>Automatic checklists (normal, abnormal and emergency procedures).</td>
<td></td>
</tr>
<tr>
<td>11.a.27</td>
<td>Runway alerting and advisory system.</td>
<td></td>
</tr>
<tr>
<td>11.a.28</td>
<td>Other.</td>
<td></td>
</tr>
<tr>
<td>11.b</td>
<td>Airborne procedures.</td>
<td></td>
</tr>
<tr>
<td>11.b.1</td>
<td>Holding.</td>
<td></td>
</tr>
<tr>
<td>11.b.2</td>
<td>Air hazard avoidance (traffic, weather, including visual correlation).</td>
<td></td>
</tr>
<tr>
<td>11.b.3</td>
<td>Wind shear:</td>
<td></td>
</tr>
<tr>
<td>11.b.3.a</td>
<td>Prior to take-off rotation.</td>
<td></td>
</tr>
<tr>
<td>11.b.3.b</td>
<td>At lift-off</td>
<td></td>
</tr>
<tr>
<td>11.b.3.c</td>
<td>During initial climb.</td>
<td></td>
</tr>
<tr>
<td>11.b.3.d</td>
<td>On final approach, below 150 m (500 ft) AGL.</td>
<td></td>
</tr>
</tbody>
</table>

**Visual System.**

This section is written in the context of the operator presenting models of real-world airports, serviced by the aeroplane type being simulated, for use in completion of the functions and subjective tests described in this appendix. The models should also be airports that are used regularly in the training programme(s) and, as applicable, may be presented for approval of circling approaches. 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).

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.

**Functional test content requirements.**

The following are the minimum airport 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.
<table>
<thead>
<tr>
<th>Number</th>
<th>Functions and Subjective Tests</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.a.1</td>
<td>Airport scenes.</td>
<td>I</td>
</tr>
<tr>
<td>12.a.1.a</td>
<td>A minimum of three (3) real-world airport models to be consistent with published data used for aeroplane operations and capable of demonstrating all the visual system features below. Each model should be in a different visual scene to permit assessment of FSTD automatic visual scene changes. Each model should be selectable from the IOS.</td>
<td>II</td>
</tr>
<tr>
<td>12.a.1.b</td>
<td>A minimum of one (1) real-world airport model to be consistent with published data used for aeroplane operations. This model should be acceptable to the operator’s NAA and selectable from the IOS.</td>
<td>III</td>
</tr>
<tr>
<td>12.a.1.c</td>
<td>A minimum of one (1) generic airport model to be consistent with published data used for aeroplane operations. This model should be acceptable to the operator’s NAA and selectable from the IOS.</td>
<td>IV</td>
</tr>
<tr>
<td>12.a.2</td>
<td>Visual scene fidelity.</td>
<td>V</td>
</tr>
<tr>
<td>12.a.2.a</td>
<td>The visual scene should correctly represent the parts of the airport and its surroundings used in the training program.</td>
<td>VI</td>
</tr>
<tr>
<td>12.a.2.b</td>
<td>The fidelity of the visual scene should be sufficient for the aircrew to visually identify the airport; determine the position of the simulated aeroplane; successfully accomplish take-offs, approaches, and landings; and manoeuvre around the airport on the ground as necessary.</td>
<td>VII</td>
</tr>
<tr>
<td>12.a.2.c</td>
<td>The fidelity of the visual scene should be sufficient for the aircrew to successfully accomplish take-offs, approaches, and landings.</td>
<td>I</td>
</tr>
<tr>
<td>12.a.3</td>
<td>Runways and taxiways.</td>
<td>II</td>
</tr>
<tr>
<td>12.a.3.a</td>
<td>The airport runways and taxiways.</td>
<td>III</td>
</tr>
<tr>
<td>12.a.3.b</td>
<td>Representative runways and taxiways.</td>
<td>IV</td>
</tr>
<tr>
<td>12.a.3.c</td>
<td>Generic runways and taxiways.</td>
<td>V</td>
</tr>
<tr>
<td>12.a.4</td>
<td>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.</td>
<td>VI</td>
</tr>
<tr>
<td>12.a.5</td>
<td>Runway threshold elevations and locations should be modelled to provide correlation with aeroplane systems (e.g. HUD, GPS, compass, altimeter).</td>
<td>VII</td>
</tr>
</tbody>
</table>
### Functions and Subjective Tests

<table>
<thead>
<tr>
<th>Number</th>
<th>Functions and Subjective Tests</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.a.6</td>
<td>Slopes in runways, taxiways, and ramp areas should not cause distracting or unrealistic effects, including pilot eye-point height variation.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.7</td>
<td>Runway surface and markings for each “in-use” runway should include the following, if appropriate:</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>12.a.7.a</td>
<td>Threshold markings.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.7.b</td>
<td>Runway numbers.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.7.c</td>
<td>Touchdown zone markings.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.7.d</td>
<td>Fixed distance markings.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.7.e</td>
<td>Edge markings.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.7.f</td>
<td>Centre line markings.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.7.g</td>
<td>Distance remaining signs.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.7.h</td>
<td>Signs at intersecting runways and taxiways.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.7.i</td>
<td>Windsock that gives appropriate wind cues.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.8</td>
<td>Runway lighting of appropriate colours, directionality, behaviour and spacing for the “in-use” runway including the following:</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>12.a.8.a</td>
<td>Threshold lights.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.8.b</td>
<td>Edge lights.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>12.a.8.c</td>
<td>End lights.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>12.a.8.d</td>
<td>Centre line lights.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>12.a.8.e</td>
<td>Touchdown zone lights.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>12.a.8.f</td>
<td>Lead-off lights.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.8.g</td>
<td>Appropriate visual landing aid(s) for that runway.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12.a.8.h</td>
<td>Appropriate approach lighting system for that runway.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Number</td>
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<tr>
<td>12.a.9</td>
<td>Taxiway surface and markings (associated with each “in-use” runway):</td>
<td>II</td>
<td></td>
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<tr>
<td></td>
<td><em>Note.</em>—The feature, if required, should be representative for Types I and III and generic for Types II and IV.</td>
<td>III</td>
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<tr>
<td>12.a.9.a</td>
<td>Edge markings</td>
<td>IV</td>
<td></td>
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<tr>
<td>12.a.9.b</td>
<td>Centre line markings.</td>
<td>V</td>
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<tr>
<td>12.a.9.c</td>
<td>Runway holding position markings.</td>
<td>VI</td>
<td></td>
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<tr>
<td>12.a.9.d</td>
<td>ILS critical area markings.</td>
<td>VII</td>
<td></td>
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<tr>
<td>12.a.9.e</td>
<td>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.</td>
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<tr>
<td>12.a.10</td>
<td>Taxiway lighting of appropriate colours, directionality, behaviour and spacing (associated with each “in-use” runway):</td>
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<tr>
<td>12.a.10.a</td>
<td>Edge lights.</td>
<td></td>
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<tr>
<td>12.a.10.b</td>
<td>Centre line lights.</td>
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<tr>
<td>12.a.10.c</td>
<td>Runway holding position and ILS critical area lights.</td>
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<tr>
<td>12.a.11</td>
<td>Required visual model correlation with other aspects of the airport environment simulation.</td>
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<tr>
<td>12.a.11.a</td>
<td>The airport model should be properly aligned with the navigational aids that are associated with operations at the runway “in-use”.</td>
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<tr>
<td>12.a.11.b</td>
<td>The simulation of runway contaminants should be correlated with the displayed runway surface and lighting.</td>
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<tr>
<td>12.a.12</td>
<td>Airport buildings, structures and lighting.</td>
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<tr>
<td>12.a.12.a</td>
<td>Buildings, structures and lighting:</td>
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<tr>
<td>12.a.12.a.1</td>
<td>The airport buildings, structures and lighting.</td>
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<tr>
<td>12.a.12.a.2</td>
<td>Representative airport buildings, structures and lighting.</td>
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<td>12.a.12.a.3</td>
<td>Generic airport buildings, structures and lighting.</td>
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<td>12.a.12.b</td>
<td>At least one useable gate, set at the appropriate height (required only for those aeroplanes that typically operate from terminal gates).</td>
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<td>VII</td>
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<tr>
<td>12.a.12.c</td>
<td>Representative moving and static gate clutter (e.g. other aeroplanes, power carts, tugs, fuel trucks, additional gates).</td>
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<tr>
<td>12.a.12.d</td>
<td>Gate/apron markings (e.g. hazard markings, lead-in lines, gate numbering), lighting and gate docking aids or a marshaller.</td>
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<tr>
<td>12.a.13</td>
<td><strong>Terrain and obstacles.</strong></td>
<td></td>
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<tr>
<td>12.a.13.a</td>
<td>Terrain and obstacles within 46 km (25 NM) of the reference airport.</td>
<td>✔</td>
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<tr>
<td>12.a.13.b</td>
<td>Representative depiction of terrain and obstacles within 46 km (25 NM) of the reference airport.</td>
<td>✔</td>
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<tr>
<td>12.a.14</td>
<td><strong>Significant, identifiable natural and cultural features.</strong></td>
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<tr>
<td>12.a.14.a</td>
<td>Significant, identifiable natural and cultural features within 46 km (25 NM) of the reference airport.</td>
<td>✔</td>
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<td></td>
<td>Note.— This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only provide a reasonable facsimile of runway orientation.</td>
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<tr>
<td>12.a.14.b</td>
<td>Representative depiction of significant and identifiable natural and cultural features within 46 km (25 NM) of the reference airport.</td>
<td>✔</td>
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<tr>
<td></td>
<td>Note.— This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only provide a reasonable facsimile of runway orientation.</td>
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<tr>
<td>12.a.14.c</td>
<td>Representative moving airborne traffic (including the capability to present air hazards — e.g. airborne traffic on a possible collision course).</td>
<td>✔</td>
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<tr>
<td>12.b</td>
<td><strong>Visual scene management.</strong></td>
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<tr>
<td>12.b.1</td>
<td>All airport runway, approach and taxiway lighting and cultural 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.</td>
<td>✔</td>
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<tr>
<td>12.b.2</td>
<td>Airport runway, approach and taxiway lighting and cultural 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.</td>
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<td>12.b.3</td>
<td>The directionality of strobe lights, approach lights, runway edge lights, visual landing aids, runway centre line lights, threshold lights, and touchdown zone lights on the runway of intended landing should be realistically replicated.</td>
<td>✓</td>
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</tbody>
</table>
| 12.c    | **Visual feature recognition.**  
*Note.*— The following are the minimum distances at which runway features should be visible. Distances are measured from runway threshold to an aeroplane aligned with the runway on an extended 3-degree glide slope in suitable simulated meteorological conditions.  
For circling approaches, all tests below apply both to the runway used for the initial approach and to the runway of intended landing. |
<p>| 12.c.1  | Runway definition, strobe lights, approach lights, and runway edge white lights from 8 km (5 sm) of the runway threshold.                                                                                                         | ✓    |
| 12.c.2  | <strong>Visual approach aids lights.</strong>                                                                                                                                                                                                  |      |
| 12.c.2.a| Visual approach aids lights from 8 km (5 sm) of the runway threshold.                                                                                                                                                             | ✓    |
| 12.c.2.b| Visual approach aids lights from 4.8 km (3 sm) of the runway threshold.                                                                                                                                                           | ✓    |
| 12.c.3  | Runway centre line lights and taxiway definition from 4.8 km (3 sm).                                                                                                                                                               | ✓    |
| 12.c.4  | Threshold lights and touchdown zone lights from 3.2 km (2 sm).                                                                                                                                                                    | ✓    |
| 12.c.5  | Runway markings within range of landing lights for night scenes; as required by the surface resolution test on day scenes.                                                                                                             | ✓    |
| 12.c.6  | For circling approaches, the runway of intended landing and associated lighting should fade into view in a non-distracting manner.                                                                                                      | ✓    |
| 12.d    | <strong>Selectable airport visual scene capability for:</strong>                                                                                                                                                                               |      |
| 12.d.1  | Night.                                                                                                                                                                                                                             | ✓    |
| 12.d.2  | Twilight.                                                                                                                                                                                                                           | ✓    |
| 12.d.3  | Day.                                                                                                                                                                                                                               | ✓    |
| 12.d.4  | Dynamic effects — the capability to present multiple ground and air hazards such as another aeroplane crossing the active runway or converging airborne traffic; hazards should be selectable via controls at the instructor station. | ✓    |</p>
<table>
<thead>
<tr>
<th>Number</th>
<th>Functions and Subjective Tests</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.d.5</td>
<td>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.</td>
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<tr>
<td>12.e</td>
<td>Correlation with aeroplane and associated equipment.</td>
<td></td>
</tr>
<tr>
<td>12.e.1</td>
<td>Visual cues to relate to actual aeroplane responses.</td>
<td>✓</td>
</tr>
<tr>
<td>12.e.2</td>
<td>Visual cues during take-off, approach and landing.</td>
<td>✓</td>
</tr>
<tr>
<td>12.e.2.a</td>
<td>Visual cues to assess sink rate and depth perception during landings.</td>
<td>PPL</td>
</tr>
<tr>
<td>12.e.2.b</td>
<td>Visual cueing sufficient to support changes in approach path by using runway perspective. Changes in visual cues during take-off, approach and landing should not distract the pilot.</td>
<td>MPL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CPL</td>
</tr>
<tr>
<td>12.e.3</td>
<td>Accurate portrayal of environment relating to aeroplane attitudes.</td>
<td>✓</td>
</tr>
<tr>
<td>12.e.4</td>
<td>The visual scene should correlate with integrated aeroplane systems, where fitted (e.g. terrain, traffic and weather avoidance systems and HUD/EFVS).</td>
<td>✓</td>
</tr>
<tr>
<td>12.e.5</td>
<td>The effect of rain removal devices should be provided.</td>
<td>✓</td>
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<tr>
<td>12.f</td>
<td>Scene quality.</td>
<td>✓</td>
</tr>
<tr>
<td>12.f.1</td>
<td>Quantization.</td>
<td>✓</td>
</tr>
<tr>
<td>12.f.1.a</td>
<td>Surfaces and textural cues should be free from apparent quantization (aliasing).</td>
<td>✓</td>
</tr>
<tr>
<td>12.f.1.b</td>
<td>Surfaces and textural cues should not create distracting quantization (aliasing).</td>
<td>✓</td>
</tr>
<tr>
<td>12.f.2</td>
<td>System capable of portraying full colour realistic textural cues.</td>
<td>✓</td>
</tr>
<tr>
<td>12.f.3</td>
<td>The system light points should be free from distracting jitter, smearing or streaking.</td>
<td>✓</td>
</tr>
<tr>
<td>12.f.4</td>
<td>System capable of providing focus effects that simulate rain.</td>
<td>✓</td>
</tr>
<tr>
<td>12.f.5</td>
<td>System capable of providing light point perspective growth.</td>
<td>✓</td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>12.g</td>
<td><strong>Environmental effects.</strong></td>
<td></td>
</tr>
<tr>
<td>12.g.1</td>
<td>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.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>12.g.2</td>
<td>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 surface and within a radius of 16 km (10 sm) from the airport.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>12.g.3</td>
<td>One airport with a snow scene, if appropriate to the operator’s area of operations, to include terrain snow and snow-covered taxiways and runways.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>12.g.4</td>
<td>In-cloud effects such as variable cloud density, speed cues and ambient changes should be provided.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>12.g.5</td>
<td>The effect of multiple cloud layers representing few, scattered, broken and overcast conditions giving partial or complete obstruction of the ground scene.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>12.g.6</td>
<td>Gradual break-out to ambient visibility/RVR, defined as up to 10% of the respective cloud base or top, 20 ft ≤ transition layer ≤ 200 ft; cloud effects should be checked at and below a height of 600 m (2 000 ft) above the airport and within a radius of 16 km (10 sm) from the airport. 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.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>12.g.7</td>
<td>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 airport and within a radius of 16 km (10 sm) from the airport.</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td></td>
<td><em>Note.— RVR only required for Types V, VI and VII.</em></td>
<td></td>
</tr>
<tr>
<td>12.g.8</td>
<td>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 &gt; IOS RVR.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>12.g.9</td>
<td>Effects of fog on airport lighting such as halos and defocus.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>12.g.10</td>
<td>Effect of ownship lighting in reduced visibility, such as reflected glare, to include landing lights, strobes, and beacons.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>12.g.11</td>
<td>Wind cues to provide the effect of blowing snow or sand across a dry runway or taxiway should be selectable from the instructor station.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13</td>
<td><strong>Motion effects.</strong></td>
<td></td>
</tr>
<tr>
<td>13.a</td>
<td>Taxiing effects such as lateral and directional cues resulting from steering and braking inputs.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.b</td>
<td>Effects of runway rumble, oleo deflections, ground speed, uneven runway, runway centre line lights, runway contamination with associated anti-skid and taxiway characteristics.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.c</td>
<td>Buffets on the ground due to spoiler/speedbrake extension and thrust.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.d</td>
<td>Bumps associated with the landing gear.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.e</td>
<td>Buffet during extension and retraction of landing gear.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.f</td>
<td>Buffet in the air due to flap and spoiler/speedbrake extension.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.g</td>
<td>Buffet due to atmospheric disturbances.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.h</td>
<td>Approach to stall buffet.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.i</td>
<td>Touchdown cues for main and nose gear.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.j</td>
<td>Nosewheel scuffing.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.k</td>
<td>Thrust effect with brakes set.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.l</td>
<td>Mach and manoeuvre buffet.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.m</td>
<td>Tire failure dynamics.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.n</td>
<td>Engine failures, malfunction, engine and airframe structural damage.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.o</td>
<td>Tail, engine pod/propeller, wing strikes.</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13.p</td>
<td>Other.</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>14</td>
<td>Sound system.</td>
<td>II</td>
</tr>
<tr>
<td>14.a</td>
<td>Precipitation.</td>
<td>III</td>
</tr>
<tr>
<td>14.b</td>
<td>Rain removal equipment.</td>
<td>IV</td>
</tr>
<tr>
<td>14.c</td>
<td>Significant aeroplane noises perceptible to the pilot during normal operations, such as engine, propeller, flaps, gear, anti-skid, spoiler extension/retraction, thrust reverser to a comparable level of that found in the aeroplane.</td>
<td>V</td>
</tr>
<tr>
<td>14.d</td>
<td>Abnormal operations for which there are associated sound cues including, but not limited to, engine malfunctions, landing gear/tire malfunctions, tail and engine pod/propeller strike and pressurization malfunction.</td>
<td>VI</td>
</tr>
<tr>
<td>14.e</td>
<td>Sound of a crash when the FSTD is landed in excess of limitations.</td>
<td>VII</td>
</tr>
<tr>
<td>15</td>
<td>Special effects.</td>
<td></td>
</tr>
<tr>
<td>15.a</td>
<td>Braking dynamics (normal and anti-skid, failure dynamics for brakes and anti-skid, reduced efficiency due to high temperature, etc).</td>
<td></td>
</tr>
<tr>
<td>15.b</td>
<td>Effects of airframe and engine icing.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Air traffic control (ATC) environment simulation system.</td>
<td></td>
</tr>
<tr>
<td>16.a</td>
<td>Dynamic automated environment.</td>
<td></td>
</tr>
<tr>
<td>16.b</td>
<td>Voice initiated transmissions, background traffic.</td>
<td></td>
</tr>
<tr>
<td>16.c</td>
<td>Automated weather reporting.</td>
<td></td>
</tr>
<tr>
<td>16.d</td>
<td>Party-line (background chatter).</td>
<td></td>
</tr>
<tr>
<td>16.e</td>
<td>Simulated communications system interaction with simulator.</td>
<td></td>
</tr>
<tr>
<td>16.f</td>
<td>Communication simulation interaction with instructor.</td>
<td></td>
</tr>
<tr>
<td>16.g</td>
<td>Message triggering.</td>
<td></td>
</tr>
<tr>
<td>16.h</td>
<td>Datalink communications.</td>
<td></td>
</tr>
<tr>
<td>16.i</td>
<td>Correlation with other traffic.</td>
<td></td>
</tr>
<tr>
<td>16.j</td>
<td>Phraseology.</td>
<td></td>
</tr>
<tr>
<td>16.k</td>
<td>Flight phase specific ATC frequency recognition.</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>16.l</td>
<td>Other communication (dispatch, maintenance, cabin crew, etc.).</td>
<td>I:</td>
</tr>
<tr>
<td>16.m</td>
<td>Instructor over-ride of the system.</td>
<td>II:</td>
</tr>
<tr>
<td>16.n</td>
<td>Other.</td>
<td>III:</td>
</tr>
<tr>
<td>17</td>
<td>Instructor Operating Station.</td>
<td>IV:</td>
</tr>
<tr>
<td>17.a</td>
<td>Repositions (repositions should be in-trim at the appropriate speed and configuration for the point):</td>
<td>V:</td>
</tr>
<tr>
<td>17.a.1</td>
<td>Ramp/gate.</td>
<td>VI:</td>
</tr>
<tr>
<td>17.a.2</td>
<td>Take-off.</td>
<td>VII:</td>
</tr>
<tr>
<td>17.a.3</td>
<td>Approach.</td>
<td></td>
</tr>
<tr>
<td>17.a.4</td>
<td>Other.</td>
<td></td>
</tr>
<tr>
<td>17.b</td>
<td>Resets:</td>
<td></td>
</tr>
<tr>
<td>17.b.1</td>
<td>System.</td>
<td></td>
</tr>
<tr>
<td>17.b.2</td>
<td>Temperature.</td>
<td></td>
</tr>
<tr>
<td>17.b.3</td>
<td>Fluids and agents.</td>
<td></td>
</tr>
<tr>
<td>17.c</td>
<td>Environment:</td>
<td></td>
</tr>
<tr>
<td>17.c.1</td>
<td>Weather presets:</td>
<td></td>
</tr>
<tr>
<td>17.c.1.a</td>
<td>Unlimited, CAVOK, VFR, non-precision, precision (CAT I, CAT II, CAT III), EFVS (if appropriate).</td>
<td></td>
</tr>
<tr>
<td>17.c.1.b</td>
<td>Unlimited, CAVOK, VFR.</td>
<td></td>
</tr>
<tr>
<td>17.c.2</td>
<td>Visual effects:</td>
<td></td>
</tr>
<tr>
<td>17.c.2.a</td>
<td>Time of day (day, dusk, night); clouds (bases, tops, layers, types, density); visibility in kilometres/statute miles; RVR in metres/feet; and special effects (precipitation; thunder storms; blowing snow, sand, etc.).</td>
<td></td>
</tr>
<tr>
<td>17.c.2.b</td>
<td>Time of day (day, dusk, night); clouds (bases, tops, layers, types, density); visibility in kilometres/statute miles; RVR in metres/feet; and special effects (precipitation; thunder storms).</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Type</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>17.c.2.c</td>
<td>Time of day (day, dusk, night); clouds (bases, tops); visibility in kilometres/statute miles.</td>
<td>✓</td>
</tr>
<tr>
<td>17.c.3</td>
<td>Wind:</td>
<td>✓</td>
</tr>
<tr>
<td>17.c.3.a</td>
<td>Surface.</td>
<td>✓</td>
</tr>
<tr>
<td>17.c.3.b</td>
<td>Intermediate levels.</td>
<td>✓</td>
</tr>
<tr>
<td>17.c.3.c</td>
<td>Typical gradient.</td>
<td>✓</td>
</tr>
<tr>
<td>17.c.3.d</td>
<td>Gust with associated heading and speed variance.</td>
<td>✓</td>
</tr>
<tr>
<td>17.c.3.e</td>
<td>Turbulence.</td>
<td>✓</td>
</tr>
<tr>
<td>17.c.4</td>
<td>Temperature – surface.</td>
<td>✓</td>
</tr>
<tr>
<td>17.c.5</td>
<td>Atmospheric pressure (QNH, QFE).</td>
<td>✓</td>
</tr>
<tr>
<td>17.d</td>
<td>Airport:</td>
<td>✓</td>
</tr>
<tr>
<td>17.d.1</td>
<td>Runway selection.</td>
<td>✓</td>
</tr>
<tr>
<td>17.d.1.a</td>
<td>To include active runway selection, and as appropriate to the airport, should be able to light at least one additional parallel or crossing runway.</td>
<td>✓</td>
</tr>
<tr>
<td>17.d.1.b</td>
<td>To include active runway selection.</td>
<td>✓</td>
</tr>
<tr>
<td>17.d.2</td>
<td>Airport lighting.</td>
<td>✓</td>
</tr>
<tr>
<td>17.d.2.a</td>
<td>Airport lighting including variable intensity and control of progressive low visibility taxiway and stop bar lighting, as appropriate.</td>
<td>✓</td>
</tr>
<tr>
<td>17.d.2.b</td>
<td>Airport lighting.</td>
<td>✓</td>
</tr>
<tr>
<td>17.d.3</td>
<td>Dynamic effects including ground and flight traffic.</td>
<td>✓</td>
</tr>
<tr>
<td>17.e</td>
<td>Aeroplane configuration (fuel, weight, cg, etc.).</td>
<td>✓</td>
</tr>
<tr>
<td>17.f</td>
<td>FMS - reloading of programmed data unless precluded by installed equipment.</td>
<td>✓</td>
</tr>
<tr>
<td>17.g</td>
<td>Plotting and recording (take-off and approach).</td>
<td>✓</td>
</tr>
<tr>
<td>17.h</td>
<td>Malfunctions (inserting and removing).</td>
<td>✓</td>
</tr>
</tbody>
</table>
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
NEW AEROPLANE FSTD QUALIFICATION

1.1 Aeroplane manufacturers’ approved final data for performance, handling qualities, systems or avionics are usually not available until well after a new or derivative aeroplane has entered service. Therefore, it may be necessary to use preliminary data provided by the aeroplane manufacturer for interim qualification of flight simulation training devices (FSTDs), so that flight crew training and certification can begin several months prior to the entry of the first aeroplane into service.

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 aeroplane 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. Aeroplane 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 aeroplane manufacturers. Each aeroplane manufacturer’s new aeroplane development and test programme is designed to suit the needs of the particular project and may not contain the same events or sequence of events as another manufacturer’s programme or even the same manufacturer’s programme for a different aeroplane. Hence there cannot be a prescribed invariable procedure for acceptance of preliminary data, but instead a statement of needs with the final sequence of events, data sources, and validation procedures agreed by the FSTD operator, the aeroplane manufacturer, the FSTD manufacturer and the NAA.

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

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

a) Manufacturer’s engineering report. Such a report will 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 aeroplane model or predict the characteristics of an earlier model and compare the results to final data for that model.

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

1.6 The use of preliminary data is not indefinite. The aeroplane manufacturer’s final data should be available within six months after the aeroplane’s entry into service or as agreed by the NAA, the FSTD operator and the aeroplane manufacturer, but usually not later than one year after entry into service. 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 but not later than two years, unless special conditions exist and a different schedule is agreed.

1.7 FSTD avionics should stay essentially in step with aeroplane avionics (hardware and software) updates. The permitted time lapse between aeroplane and FSTD updates is not a fixed time but should be minimal. It may depend on the magnitude of the update and whether the QTG and pilot training and checking are affected. Permitted differences in aeroplane and FSTD avionics versions 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 based upon a mix of flight test and engineering simulation data. For data collected from specific aeroplane flight tests or other flights, the required design model/data changes necessary to support an acceptable Proof of Match (POM) should be generated by the aeroplane manufacturer.

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

   a) propulsion;
   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 aeroplane types, it may be beneficial that the services of a suitably qualified NAA or aeroplane manufacturer’s test pilot be used for the purpose of assessing handling qualities and evaluating performance.
Attachment B

ENGINEERING SIMULATION VALIDATION DATA

1. BACKGROUND

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

1.2 Traditionally as the aeroplane configuration has been revised, the simulation models have 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 new models and validation data.

1.3 The quality of the prediction of simulation models has advanced to the point where differences between predicted and flight-test-validated models are often quite small.

1.4 The major aeroplane manufacturers utilize the same simulation models in their engineering simulations as those released to the training community. These simulations vary from physical engineering simulators with and without aeroplane hardware to non-real-time workstation-based simulations.

2. APPROVAL GUIDELINES FOR USING ENGINEERING SIMULATION VALIDATION DATA

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

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

2.3 In cases where data from an engineering simulator are used, the appropriate NAA(s) is responsible for auditing the engineering simulation process.

2.4 In all cases, a data package verified to current standards against flight tests should be available for the aeroplane “entry-into-service” configuration of the baseline aeroplane.

2.5 Where engineering simulator data are used as part of a QTG, a close match is expected as described in Attachment C of 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 include evidence of the aeroplane manufacturer’s past achievements in high-fidelity modelling.

2.7 The process will be applicable to “one-step” away from a fully flight-validated simulation model.
2.8 A configuration management process should be maintained, including an audit trail which clearly defines the simulation model changes “step-by-step” away from a fully flight-validated simulation model, so that it would be possible to remove the changes and return to the baseline (flight-validated) version.

2.9 The NAA(s) will conduct technical reviews of the proposed plan and of the subsequent validation data to establish acceptability of the proposal.

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

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

   a) have to exist as a physical entity, complete with a flight deck, 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 aeroplane by the pilots of the manufacturers, operators and the NAA(s).

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

   a) the original (baseline) simulation models should have been fully flight-test-validated;
   b) the models as released by the aeroplane manufacturer to the industry for the FSTD used in training should be essentially identical to those used by the aeroplane manufacturer in its engineering simulations/simulators; and
   c) these engineering simulations/simulators will have been used as part of the aeroplane design, development and certification process.

2.13 FSTD used for training and utilizing the baseline simulation models should be currently qualified to 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”:

   a) software (e.g. flight control computer, autopilot);
   b) simple (in aerodynamic terms) geometric revisions (e.g. fuselage length);
   c) engines, limited to non-propeller-driven aeroplanes;
   d) control system gearing/rigging/deflection limits; and
   e) brake, tire and steering revisions.
2.15 The manufacturer who wishes to take advantage of this alternative procedure is expected to demonstrate a sound engineering basis for 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.
1. BACKGROUND

1.1 The tolerances listed in Appendix B of 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 1.6 of this attachment.

1.3 When applying tolerances to any test, good engineering judgment with reference to section 1.6 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 non-flight test data as reference data was in the past quite small and thus these tolerances were used for all tests. Over the last few years, the inclusion of this type of data as a validation source has rapidly expanded and will probably continue to expand.

1.5 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.

1.6 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 units and flight controls);
   b) modelling solutions used in the FSTD are different to the ones 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.

1.7 Any differences between FSTD results and engineering validation data should, however, be small and the reasons for any differences, other than those listed in 1.6 of this attachment, should be clearly explained.

1.8 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.

1.9 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;
   b) alternative technical solutions are being advanced; and
   c) cost is an ever-present consideration.

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

2. NON-FLIGHT TEST TOLERANCES

2.1 Where engineering validation data or other non-flight test 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 non-flight test 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. 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.
2.3 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.

2.4 The validation data suppliers (aircraft manufacturers) may identify cases where the suggested 40 per cent tolerance cannot be met. In such cases the data suppliers should provide a clear rationale as part of their validation data roadmap.

2.5 Where the engineering simulation used to generate reference data includes aeroplane 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 Aeroplane manufacturers or other sources of data should supply a validation data roadmap (VDR) document as part of the data package. A VDR document contains guidance material from the aeroplane validation data supplier recommending the best possible sources of data to be used as validation data in the QTG. A VDR is of special value in the cases of requests for interim qualification, requests for qualification of simulations of aeroplanes certificated prior to 1992, and for qualification of alternate engine or avionics fits (see Attachment E). 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 validation data roadmap should clearly identify (in matrix format) sources of data for all required tests. It should also provide guidance regarding the validity of these data for a specific engine type and thrust rating configuration and the revision levels of all avionics affecting aeroplane handling qualities and performance. The document should include rationale or explanation in cases where data or parameters are missing, engineering simulation data are to be used, flight test methods require explanation, etc., together with a brief narrative describing the cause/effect of any deviation from data requirements. Additionally, the document should make reference to other appropriate sources of validation data (e.g., sound and vibration data documents).

1.3 Table D-1 depicts a generic roadmap matrix identifying sources of validation data. Only the first page of the full matrix is shown and some test conditions were deleted for brevity. The first column refers to validation tests in Appendix B of this Part or to tests in the IATA document Flight Simulator Design and Performance Data Requirements. Relevant regulatory material should be consulted and all applicable tests addressed in the actual validation data roadmap (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.

1.3.1 Include CCA mode column if applicable.

1.3.2 Include column for each validation source (e.g., each flight test airframe/engine combination and the simulation configuration).

1.3.3 Include column for each document being referenced as a source of validation data. The term “integrated” in the document title indicates that test conditions contained in these documents conform to the definition of integrated testing as described in the glossary.

1.3.4 Data type numbering should align with the hierarchy of preferences outlined in paragraph 1.5 of Attachment J.

1.4 Tables D-2 and D-3 provide examples of another presentation of roadmap matrices identifying sources of validation data for an abbreviated list of tests along with detailed information for a typical test case. A complete matrix should address all test conditions. A complete set of detailed information pages for tests quoted in the matrix would be provided with this particular presentation.
1.5 Additionally, two examples of “rationale pages” are presented in Appendix F of the IATA document *Flight Simulator Design and Performance Data Requirements*. These illustrate the type of aeroplane and avionics configuration information and descriptive engineering rationale used to describe data anomalies, provide alternative data, or provide to the NAA an acceptable basis for obtaining deviations from QTG validation requirements.
## Table D-1. Validation of Data Roadmap

<table>
<thead>
<tr>
<th>ICAO/IATA#</th>
<th>Test description</th>
<th>Validation source</th>
<th>Validation document</th>
<th>Validation source category</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.a (1)</td>
<td>Minimum radius turn.</td>
<td>N</td>
<td>2</td>
<td>NE</td>
<td>FT (This VDR is for aircraft 2 with DEF-74 engines)</td>
</tr>
<tr>
<td>1.a (2)</td>
<td>Rate of turn versus nosewheel steering angle (2 speeds).</td>
<td>N</td>
<td>3</td>
<td></td>
<td>ES Data is included in normal take-off (1.b (4)).</td>
</tr>
<tr>
<td>1.b (1)</td>
<td>Ground acceleration time and distance.</td>
<td>N</td>
<td>3</td>
<td>D74</td>
<td>ES Data is included in normal take-off (1.b (4)).</td>
</tr>
<tr>
<td>1.b (2)</td>
<td>Minimum control speed, ground (V_{mcp}).</td>
<td>N</td>
<td>1</td>
<td>D74</td>
<td>FT Test procedure anomaly; see rationale.</td>
</tr>
<tr>
<td>1.b (3)</td>
<td>Minimum unstick speed (V_{mu}).</td>
<td>N</td>
<td>3</td>
<td>D74</td>
<td>ES Test procedure anomaly; see rationale.</td>
</tr>
<tr>
<td>1.b (4)</td>
<td>Normal take-off.</td>
<td>N</td>
<td>2</td>
<td>D74</td>
<td>FT Test procedure anomaly; see rationale.</td>
</tr>
<tr>
<td>1.b (5)</td>
<td>Critical engine failure on take-off.</td>
<td>N</td>
<td>1</td>
<td>D74</td>
<td>FT Test procedure anomaly; see rationale.</td>
</tr>
<tr>
<td>1.b (6)</td>
<td>Crosswind take-off.</td>
<td>N</td>
<td>1</td>
<td>D74</td>
<td>FT  Test procedure anomaly; see rationale.</td>
</tr>
<tr>
<td>1.b (7)</td>
<td>Rejected take-off.</td>
<td>N</td>
<td>1</td>
<td>D74</td>
<td>FT/E S Test procedure anomaly; see rationale.</td>
</tr>
<tr>
<td>1.b (8)</td>
<td>Dynamic engine failure after take-off.</td>
<td>N</td>
<td>1</td>
<td>D74</td>
<td>FT Test procedure anomaly; see rationale.</td>
</tr>
<tr>
<td>1.c (1)</td>
<td>Normal climb all engines operating.</td>
<td>N, D</td>
<td>2</td>
<td>D73</td>
<td>ES R FT data flown in direct mode; see rationale.</td>
</tr>
<tr>
<td>1.c (2)</td>
<td>One-engine-inoperative 2nd segment climb.</td>
<td>N</td>
<td>1</td>
<td>D74</td>
<td>FT AFM data available for reference.</td>
</tr>
<tr>
<td>1.c (3)</td>
<td>One-engine-inoperative en-route climb.</td>
<td>N</td>
<td>3</td>
<td>D74</td>
<td>ES Run with and without icing accountability.</td>
</tr>
<tr>
<td>1.c (4)</td>
<td>One-engine-inoperative approach climb.</td>
<td>N</td>
<td>3</td>
<td>D74</td>
<td>ES Run with and without icing accountability.</td>
</tr>
</tbody>
</table>
### Manual of Criteria for the Qualification of Flight Simulation Training Devices — Volume I

| 1.d (1) | Level flight acceleration. | N | 2 | 3 | C78 | D74 | FT/ES | R | FSTD manufacturer to evaluate use of FT in QTG. |
| 1.d (2) | Level flight deceleration. | N | 2 | 3 | C78 | D74 | FT/ES | R | FSTD manufacturer to evaluate use of FT in QTG. |
| 1.d (3) | Cruise performance. | N | 3 | | | | | | |
| 1.d (4) | Idle descent. | N | 3 | | | | | | |
| 1.d (5) | Emergency descent. | N | 3 | | | | | | |
| 1.e (1) | Deceleration time and distance (wheel brakes). | N | 2 | | D73 | | | | FT
| 1.e (2) | Deceleration time and distance (reverse thrust). | N | 2 | 3 | d73 | D74 | ES | |
| 1.e (3) | Stopping distance, wheel brakes, wet runway. | N | 2 | 3 | D73 | d73 | FT | |
| 1.e (4) | Stopping distance, wheel brakes, icy runway. | N | 2 | 3 | D73 | d73 | FT | |
| 3.3.3.7 | Brake fade (hot brakes). IATA reference 3.3.3.7-1. | 3 | | | | | | |

#### Validation source – Data type key:

1. Flight test data – Exact configuration.  
2. Flight test data – Similar configuration.  
3. Engineering simulation data.  
4. Aeroplane flight manual data.

#### Shading key:

- **Recommended data.**  
- ** UPPER CASE:** Preferred data.  
- **Data options Available.**  
- **lower case:** Reference or secondary data.  
- **Reference data only.**

#### Validation document – Engine type/rating key:

- C78 – Engine type: CEF-78, thrust rating: 78 kN.  
- D73 – Engine type: DEF-73, thrust rating: 73 kN.  
- D74 – Engine type: DEF-74, thrust rating: 74 kN.  
- NE – Independent of engine model or no engine model used.

#### Validation source category:

- **FT** Flight test data recommended for QTG. Engineering simulation data may be provided for reference and checkout purposes.  
- **FT/ES** Flight test data are provided as a potential validation data source, with engineering simulation data provided as a supplementary resource if required.  
- **ES** Engineering simulation data recommended for QTG, with flight test data provided as available for reference purposes.
<table>
<thead>
<tr>
<th>QTG</th>
<th>Test description</th>
<th>CCA mode</th>
<th>Validation source</th>
</tr>
</thead>
<tbody>
<tr>
<td>A = Engine 1: xx kN. B = Engine 2: xx kN. D: Direct Law. N: Normal Law. Alt: Alternate law or system alternate conditions (e.g. hydraulics off).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.a (1)</td>
<td>Minimum radius turn.</td>
<td>N B B</td>
<td>X</td>
</tr>
<tr>
<td>1.a (2)1</td>
<td>Rate of turn versus nosewheel steering angle – Speed 1.</td>
<td>D A A A</td>
<td>X</td>
</tr>
<tr>
<td>1.a (2)2</td>
<td>Rate of turn versus nosewheel steering angle – Speed 2.</td>
<td>D A A A</td>
<td>X</td>
</tr>
<tr>
<td>1.b (1)</td>
<td>Ground acceleration time and distance.</td>
<td>N B B B</td>
<td>X</td>
</tr>
<tr>
<td>1.b (2)</td>
<td>Minimum control speed, ground (V_{mao}).</td>
<td>D B B B</td>
<td>X</td>
</tr>
<tr>
<td>1.b (3)</td>
<td>Minimum unstick speed (V_{mu}).</td>
<td>D A A B</td>
<td>X</td>
</tr>
<tr>
<td>1.b (4)1</td>
<td>Normal take-off - Max weight – Alt CG.</td>
<td>N B B B</td>
<td>X</td>
</tr>
<tr>
<td>1.b (4)2</td>
<td>Normal take-off - Light weight – Mid CG.</td>
<td>N B B B</td>
<td>X</td>
</tr>
<tr>
<td>1.b (5)</td>
<td>Critical engine failure on take-off – Normal mode</td>
<td>N B B B</td>
<td>X</td>
</tr>
<tr>
<td>1.b (6)</td>
<td>Crosswind take-off.</td>
<td>N C C C</td>
<td>X</td>
</tr>
<tr>
<td>1.b (7)1</td>
<td>Rejected take-off – Pedal braking.</td>
<td>D A A A</td>
<td>X</td>
</tr>
<tr>
<td>1.b (7)2</td>
<td>Rejected take-off – Autobrake.</td>
<td>N B B B</td>
<td>X</td>
</tr>
<tr>
<td>1.b (8)1</td>
<td>Dynamic engine failure after take-off, non-normal mode.</td>
<td>D B B B</td>
<td>X</td>
</tr>
<tr>
<td>1.b (8)2</td>
<td>Dynamic engine failure after take-off, normal mode.</td>
<td>N B B B</td>
<td>X</td>
</tr>
<tr>
<td>QTG</td>
<td>Test description</td>
<td>Validation source</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>------------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>1.c (1)</td>
<td>Normal climb all engines operating.</td>
<td>N</td>
<td>A</td>
</tr>
<tr>
<td>1.c (2)</td>
<td>One-engine-inoperative 2nd segment climb.</td>
<td>N</td>
<td>A</td>
</tr>
<tr>
<td>1.c (3)</td>
<td>One-engine-inoperative en-route climb.</td>
<td>N</td>
<td>A</td>
</tr>
<tr>
<td>1.c (4)</td>
<td>One-engine-inoperative approach climb.</td>
<td>N</td>
<td>A</td>
</tr>
<tr>
<td>1.d (1)</td>
<td>Level flight acceleration.</td>
<td>N</td>
<td>A</td>
</tr>
<tr>
<td>1.d (2)</td>
<td>Level flight deceleration.</td>
<td>N</td>
<td>A</td>
</tr>
<tr>
<td>1.d (4)</td>
<td>Idle descent.</td>
<td>N</td>
<td>A</td>
</tr>
</tbody>
</table>

A = Engine 1: xx kN.
B = Engine 2: xx kN.
D: Direct Law.
N: Normal Law.
Alt: Alternate law or system alternate conditions (e.g. hydraulics off).
### Table D-3. Recommended Qualification Test Guide – 2

<table>
<thead>
<tr>
<th>1. PERFORMANCE</th>
<th>1.a. TAXI</th>
<th>1.a (2) Rate of turn versus nosewheel steering angle (NWA)</th>
<th>Conditions: Ground.</th>
</tr>
</thead>
</table>

#### A – Requirements

**Document:** ICAO 9625, Third Edition.

**Tolerance:** \( \pm 2^\circ/s \) or \( \pm 10\% \) of turn rate.

**Flight Condition:** Ground.

**Comments:** Plot a minimum of two speeds, greater than minimum turning radius speed, with a spread of at least 5 knots ground speed.

**Type:**

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

#### B – Data Package

<table>
<thead>
<tr>
<th>Configuration:</th>
<th>#</th>
<th>Avionics 1</th>
<th>FCSC</th>
<th>FADEC</th>
<th>BSCU</th>
<th>Flight test validation data</th>
<th>Engineering validation data</th>
<th>Proof of match</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
<td>XXXXXXX Engine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
<td></td>
<td>XXXXXXX Engine</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
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<td></td>
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<tr>
<td>5</td>
<td></td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
<td>Std xx</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Rationale</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>----</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Rationale 1.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>Rationale 2.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3</td>
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<td>5</td>
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</tr>
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<td>6</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
Attachment E

GUIDELINES FOR ADDITIONAL/ALTERNATE ENGINES OR AVIONICS VALIDATION DATA

1. BACKGROUND

1.1 For a new aeroplane type, the majority of flight validation data is collected on the first aeroplane configuration with a “baseline” engine fit and a “baseline” avionics configuration. This data set is then used to validate all FSTDs representing that aeroplane type.

1.2 In the case of FSTDs representing an aeroplane with a different engine fit than the baseline, or with a revised avionics configuration 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 only require a subset of the QTG as defined in paragraph 2 of this attachment.

1.5 When an FSTD with alternate avionics configurations 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 paragraph 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 paragraph 4 of this attachment, except where other data are specifically allowed (see Attachment B of 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 or thrust ratings. The primary engine fit for a given FSTD will be validated by running the entire QTG for that engine fit. To validate additional engine types or thrust ratings in that FSTD a subset of the QTG should be provided. The test conditions (one per test number) in Table E-1 should be included in that subset, as a minimum.

2.2 When the additional engine fit is a different type from the primary configuration (i.e. “baseline”), all the tests under the additional engine type column in Table E-1 should be provided in the QTG.

2.3 In the case where the additional engine type is the same, but the thrust rating exceeds that of the primary configuration (i.e. ‘baseline’) by five per cent or more, or is significantly less than the primary configuration engine rating (a decrease of fifteen per cent or more), all the tests in the additional engine rating column should be provided in the QTG. Otherwise, it might be acceptable to only provide the throttle calibration data (i.e. commanded power setting parameter versus throttle lever angle), and the engine acceleration and deceleration cases.
Table E-1. Minimum recommended list of QTG tests for an additional engine configuration

<table>
<thead>
<tr>
<th>TEST NUMBER</th>
<th>TEST DESCRIPTION</th>
<th>ADDITIONAL ENGINE TYPE</th>
<th>ADDITIONAL ENGINE RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.b (1), (4)</td>
<td>Ground acceleration time and distance / normal take-off.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.b (2)</td>
<td>Minimum control speed, ground ($V_{mcg}$).</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1.b (5)</td>
<td>Critical engine failure on take-off.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.b (7)</td>
<td>Rejected take-off.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.b (8)</td>
<td>Dynamic engine failure after take-off.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.c (1)</td>
<td>Normal climb all engines operating.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1.c (2)</td>
<td>One–engine-inoperative 2nd segment climb.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1.d (1)</td>
<td>Level flight acceleration.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.d (2)</td>
<td>Level flight deceleration.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.d (3)</td>
<td>Cruise performance.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.f (1), (2)</td>
<td>Engine acceleration and deceleration.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.a (8)</td>
<td>Alignment of cockpit throttle lever angle versus selected engine parameter (throttle calibration).</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.c (1)</td>
<td>Power change dynamics.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.d (1)</td>
<td>Minimum control speed, air ($V_{maa}$).</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.d (5)</td>
<td>Engine-inoperative trim.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.e (4)</td>
<td>One-engine-inoperative landing.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.e (6)</td>
<td>All-engine autopilot go-around.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.e (7)</td>
<td>One-engine-inoperative go-around.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.e (8)</td>
<td>Directional control with reverse thrust (symmetric).</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.e.9</td>
<td>Directional control with reverse thrust (asymmetric).</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3.f (1)</td>
<td>Thrust effects with brakes set.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5.a (3)</td>
<td>All engines at maximum allowable thrust with brakes set.</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

3. QTG GUIDELINES FOR THE QUALIFICATION OF AN ALTERNATE AVIONICS CONFIGURATION

3.1 The following guidelines apply to FSTDs representing aeroplanes with a revised avionics configuration or more than one avionics configuration.

3.2 The aeroplane avionics can be segmented into those systems or components that can significantly affect the QTG results and those that cannot. The following avionics 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, autopilot, braking system, nosewheel
steering system, high-lift system and landing gear system. Related avionics such as stall warning and augmentation systems should also be considered. The aeroplane manufacturer should identify, for each avionics system change, the affected QTG tests. The aeroplane manufacturer should identify for each validation test affected by an avionics change what the effect is.

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 affecting a different flight phase), the QTG test can be based on validation data from the previously-validated avionics configuration. The aeroplane manufacturer should clearly state that this avionics change does not affect the test.

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 aeroplane response is a small, well-understood effect, the QTG may be based on validation data from the previously-validated avionics configuration. This should be supplemented with avionics-specific validation data from the aeroplane manufacturer’s engineering simulation generated with the revised avionics configuration. In such cases, the aeroplane manufacturer should provide a rationale explaining the nature of the change and its effect on the aeroplane response.

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. 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 manufacturer should coordinate FSTD data requirements in this situation in advance with the NAA.

3.6 For changes to an avionics system or component that are non-contributory to QTG validation test response, the QTG test can be based on validation data from the previously-validated avionics configuration. For such changes, it is not necessary to include an authoritative justification (e.g. from the aeroplane manufacturer or the system supplier) that this avionics change does not affect the test.

4. VALIDATION DATA REQUIREMENT GUIDELINES FOR ALTERNATE ENGINE FITS AND ALTERNATE AVIONICS CONFIGURATIONS

4.1 For tests that are affected by difference in engine type or in thrust rating as prescribed by paragraph 2, flight test data would be preferred to validate that particular aeroplane-engine configuration or the alternate thrust rating. Table E-2 presents a minimum list of validation tests that should be supported by flight test data.

4.2 If certification of the flight characteristics of the aeroplane with a new thrust rating (regardless of thrust rating percentage change) does require certification flight testing with a comprehensive stability and control flight instrumentation package, then the list of tests detailed in Table E-2, as a minimum, should be supported by flight test data and presented in the QTG (along with additional tests listed in Table E-1 for which other sources of validation data are acceptable). Flight test data, other than throttle calibration and engine acceleration and deceleration data, are not required if the new thrust rating is certified on the aeroplane without need for a comprehensive stability and control flight instrumentation package.

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 of this Part). The FSTD manufacturer should coordinate FSTD data requirements pertaining to alternate engines or avionics configurations in advance with the NAA.
Table E-2. Minimum recommended list of validation flight tests for an alternate engine configuration.

<table>
<thead>
<tr>
<th>TEST NUMBER</th>
<th>TEST DESCRIPTION</th>
<th>ALTERNATE ENGINE TYPE</th>
<th>ALTERNATE THRUST RATING²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.b (1), (4)</td>
<td>Ground acceleration time and distance / normal take-off.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1.b (2)</td>
<td>Minimum control speed, ground (V_{mcg}), if performed for aeroplane certification.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1.b (5)</td>
<td>Critical engine failure on take-off.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.b (8)</td>
<td>Dynamic engine failure after take-off.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.b (7)</td>
<td>Rejected take-off, if performed for aeroplane certification.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.d (3)</td>
<td>Cruise performance.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.f (1), (2)</td>
<td>Engine acceleration and deceleration(^1).</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.a (8)</td>
<td>Alignment of cockpit throttle lever versus selected engine parameter (throttle calibration)(^1).</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.c. (1)</td>
<td>Power change dynamics (acceleration).</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.d (1)</td>
<td>Minimum control speed, air (V_{mca}), if performed for aeroplane certification.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.d (5)</td>
<td>Engine-inoperative trim.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.e (1)</td>
<td>Normal landing.</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Note 1.— Should be provided for all changes in engine type or thrust rating (see 2.3).
Note 2.— See 2.3 for a definition of applicable thrust ratings.
1. BACKGROUND

1.1 The objective of this Attachment is to offer guidance on an 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 officers 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 upon 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 to attenuate the input signals in such a way that the motion platform remains within its mechanical limits.

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 simulated flight 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 system includes the following:

a) the motion cueing algorithm;
b) the motion platform actuator extension transformation and control laws;
c) the motion platform hardware, that reacts to these transformed aircraft motion commands; and
d) 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. 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 motion platform responses measured at \( \Phi \) compared to the input at \( \Theta \), 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 are described in paragraph 7.4

1.10 The MDA is defined here as the set of 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 capture the transport delays introduced by these processes and also any delays in the related computer equipment used in the motion system. In some cases, the MDA may be integrated in the host computer, and in others 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 on the ground, and again in flight. If these settings are not changed between ground and air 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.

<table>
<thead>
<tr>
<th>Input Signal Number</th>
<th>Frequency [rad/s]</th>
<th>Frequency [Hertz]</th>
<th>Modulus M [non-dimensional]</th>
<th>Phase $\phi$ [deg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.100</td>
<td>0.0159 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.158</td>
<td>0.0251 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.251</td>
<td>0.0399 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.398</td>
<td>0.0633 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.631</td>
<td>0.1004 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1.000</td>
<td>0.1591 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1.580</td>
<td>0.251 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2.512</td>
<td>0.399 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>3.981</td>
<td>0.633 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>6.310</td>
<td>1.004 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>10.000</td>
<td>1.591 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>15.849</td>
<td>2.515 Hz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2.1  The relationship between the frequency and corresponding modulus $M$ and the corresponding phase $\phi$ defines the system frequency response. This test requires that for each degree-of-freedom, measurements at 12 discrete frequencies are taken. It should be noted that as more experience is gained with this test for a specific application, the exact number of discrete frequencies required may change.

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 $\phi$ are defined as:

$M(\omega) = \text{amplitude of output } u(\omega) / \text{amplitude of input } i(\omega)$

$\phi(\omega) = \Delta t \omega 360 / 2\pi \text{ [deg]}$

**Note.**— A description of symbols and notations is provided in paragraph 7.


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 using the OMCT signal generator as shown in Figure F-2. These tests stimulate the motion cueing system in a way similar to the aircraft model output in the flight simulator. The test signal represents the aircraft state variables ($\varphi_{a/c}$, $\theta_{a/c}$, and $\psi_{a/c}$; $\dot{\varphi}_{a/c}$, $\dot{\theta}_{a/c}$, and $\dot{\psi}_{a/c}$). 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 the following equation, using the amplitudes $A$ given in Table F-2:

$$f_{a/c}^{x,y,z}(t) = A \sin(\omega t).$$

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 $\omega$ in rad/sec. 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-2. Specific force input amplitudes

<table>
<thead>
<tr>
<th>Frequency signal number</th>
<th>Frequency [rad/s]</th>
<th>Frequency [Hz]</th>
<th>Amplitude A [m/s^2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.100</td>
<td>0.0159 Hz</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>0.158</td>
<td>0.0251 Hz</td>
<td>1.00</td>
</tr>
<tr>
<td>3</td>
<td>0.251</td>
<td>0.0399 Hz</td>
<td>1.00</td>
</tr>
<tr>
<td>4</td>
<td>0.398</td>
<td>0.0633 Hz</td>
<td>1.00</td>
</tr>
<tr>
<td>5</td>
<td>0.631</td>
<td>0.1004 Hz</td>
<td>1.00</td>
</tr>
<tr>
<td>6</td>
<td>1.000</td>
<td>0.1591 Hz</td>
<td>1.00</td>
</tr>
<tr>
<td>7</td>
<td>1.585</td>
<td>0.251 Hz</td>
<td>1.00</td>
</tr>
<tr>
<td>8</td>
<td>2.512</td>
<td>0.399 Hz</td>
<td>1.00</td>
</tr>
<tr>
<td>9</td>
<td>3.981</td>
<td>0.633 Hz</td>
<td>1.00</td>
</tr>
<tr>
<td>10</td>
<td>6.310</td>
<td>1.004 Hz</td>
<td>1.00</td>
</tr>
<tr>
<td>11</td>
<td>10.000</td>
<td>1.591 Hz</td>
<td>1.00</td>
</tr>
<tr>
<td>12</td>
<td>15.849</td>
<td>2.515 Hz</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Table F-3. Rotational input amplitudes

<table>
<thead>
<tr>
<th>Aircraft pitch</th>
<th>Aircraft roll</th>
<th>Aircraft yaw</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_{a/c}(t) = A \sin(\omega t)$</td>
<td>$\phi_{a/c}(t) = A \sin(\omega t)$</td>
<td>$\psi_{a/c}(t) = A \sin(\omega t)$</td>
</tr>
<tr>
<td>$q_{a/c}(t) = A \omega \cos(\omega t)$</td>
<td>$p_{a/c}(t) = A \omega \cos(\omega t)$</td>
<td>$r_{a/c}(t) = A \omega \cos(\omega t)$</td>
</tr>
<tr>
<td>$\dot{q}_{a/c}(t) = -A \omega^2 \sin(\omega t)$</td>
<td>$\dot{p}_{a/c}(t) = -A \omega^2 \sin(\omega t)$</td>
<td>$\dot{r}_{a/c}(t) = -A \omega^2 \sin(\omega t)$</td>
</tr>
</tbody>
</table>

Table F-4. Rotational input amplitudes given by attitude, angular rate or acceleration

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.100</td>
<td>0.0159 Hz</td>
<td>6.00</td>
<td>0.600</td>
<td>0.060</td>
</tr>
<tr>
<td>2</td>
<td>0.158</td>
<td>0.0251 Hz</td>
<td>6.00</td>
<td>0.948</td>
<td>0.150</td>
</tr>
<tr>
<td>3</td>
<td>0.251</td>
<td>0.0399 Hz</td>
<td>3.984</td>
<td>1.000</td>
<td>0.251</td>
</tr>
<tr>
<td>4</td>
<td>0.398</td>
<td>0.0633 Hz</td>
<td>2.513</td>
<td>1.000</td>
<td>0.398</td>
</tr>
<tr>
<td>5</td>
<td>0.631</td>
<td>0.1004 Hz</td>
<td>1.585</td>
<td>1.000</td>
<td>0.631</td>
</tr>
<tr>
<td>6</td>
<td>1.000</td>
<td>0.1591 Hz</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>
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-4. 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.

5. OMCT TEST DESCRIPTION

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 specific force response due to aircraft pitch input;
3. FSTD roll response to aircraft roll input;
4. FSTD sway specific force response due to aircraft roll input;
5. FSTD yaw response to aircraft yaw input;
6. FSTD surge specific force response to aircraft surge input;
7. FSTD pitch rate and pitch acceleration response to aircraft surge input;
8. FSTD sway specific force response to aircraft sway input;
9. FSTD roll rate and pitch acceleration response to aircraft sway input; and
10. FSTD heave specific force 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.
Table F-5. Test matrix with test numbers

<table>
<thead>
<tr>
<th>Aircraft Input Signal</th>
<th>Pitch</th>
<th>Roll</th>
<th>Yaw</th>
<th>Surge</th>
<th>Sway</th>
<th>Heave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitch</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roll</td>
<td></td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yaw</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surge</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sway</td>
<td>7</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heave</td>
<td>9</td>
<td>8</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 the phase. The test should be run in two separate configurations to cater for on ground and in flight states; for each of these test configurations, ten tables should be presented as described in section 2.1 of this attachment. The results should also be plotted for each component in the test matrix, 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 5.1 yields such a plot. Here, 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 additional 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 minimum boundaries for the modulus and 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. Definition of acceptability bounds is an ongoing activity and will be addressed by the ICFQ.

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

- $\theta$ pitch angle [deg]
- $\phi$ roll angle [deg]
- $\psi$ yaw angle [deg]
- $\omega$ frequency [rad/s]
- $\phi$ phase angle [deg]
- $A$ amplitude
- $M$ Modulus
- $a$ linear acceleration $[\text{m/s}^2]$
- $f$ specific force $[\text{m/s}^2]$
- $g$ gravity $[\text{m/s}^2]$
- $i$ input signal
- $\rho$ roll rate [deg/s]
- $q$ pitch rate [deg/s]
- $r$ yaw rate [deg/s]
- $u$ output signal (or response)
- $t$ time [s]
- $\Delta t$ measured phase delay [s]
7.2 **Subscript indices**

- A  aircraft
- a/c  aircraft
- sim  simulator
- PA  aircraft pilot
- PS  simulator pilot

7.3 **Superscript indices**

- \(x, y, z\) along the 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.

![Diagram of Frames of Reference](image-url)

**Figure F-5.** Aircraft and simulator frames of reference relevant to MDAs
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 $F_A$ 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.
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.

![Diagram of transport delay and latency testing](image)

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 aeroplane 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 aeroplane 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 aeroplane. 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 re-qualifications 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 100/200 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 aeroplanes. In the case of classic, non-computer-controlled aeroplanes, no further analysis will be necessary.

2.3 Computer-controlled-aeroplanes. For FSTDs of aeroplanes 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 aeroplane 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 aeroplane, 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 aeroplane or avionics. Alternatively the aeroplane equipment may be by-passed, provided that the signal path is maintained in terms of FSTD interfaces. A schematic diagram should be provided to present that part of the aeroplane 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 aeroplane 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.

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 aeroplane 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 paragraph 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 aeroplane 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 aeroplane 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 aeroplane 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 aeroplane responses. To determine aeroplane 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 aeroplane and FSTD responses be measured accurately to enable a meaningful test result.

3.5 Aeroplane 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 aeroplane data are employed as the benchmark, it is necessary to establish the aeroplane 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 aeroplane 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 aeroplane 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 aeroplane reaching 10 per cent of its maximum acceleration in ms should be used as the aeroplane 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 aeroplane 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 aeroplane 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 aeroplane response time in ms. This time is subject to the test tolerance.

3.9 Computer controlled aeroplanes and other special cases. Guidance already provided above for the transport delay tests for computer controlled aeroplanes and other special cases can be applied to the latency tests.

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**Figure G-2. Transport delay with avionics elements**
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 evaluation test results are compared.

1.2 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 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 is 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 Type VII 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.

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.

2. PRESENTATION OF RECURRENT EVALUATION TEST RESULTS

2.1 The method described below to present recurrent validation test results is offered solely to promote greater efficiency for operators while conducting recurrent FSTD validation testing. The efficiency 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 or class of aeroplanes. 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 simulation feature fidelity “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 applicable to the standard ICAO Type I to IV device categories, as defined in Chapter 2, Table 2-1, of this Part.

2. DESIGN STANDARDS

2.1 Simulated aeroplane configuration

2.1.1 The configuration chosen should sensibly represent the aeroplane or aeroplanes likely to be used in the training programme. Areas such as general layout, seating, instruments and avionics, control type, control force and position, performance and handling and engine configuration should be representative of the class of aeroplane or the aeroplane itself.

2.1.2 It would be in the interest of all parties to engage in early discussions with the NAA to broadly agree a suitable configuration, the so-called “designated aeroplane 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/flight deck. The cockpit/flight deck should be representative of the designated aeroplane configuration. To ensure a good training environment, the cockpit/flight deck should be sufficiently enclosed to minimize any distractions. The controls, instruments and avionics controllers should be representative with respect to touch, feel, layout, colour and lighting to create a positive learning environment and to allow for a good transfer of training to the aeroplane.

2.3 Cockpit/flight deck components. As with any training device, the components used within the cockpit/flight deck area do not need to be aircraft parts. However, any parts used should be representative of typical training aeroplanes and should be robust enough to endure the training tasks. With the current state of technology, the use of simple flat display technology-based representations 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 an aeroplane 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 aeroplane 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 aeroplane within the group of aeroplanes that the FSTD is intended to represent, or they may be based on information from several aeroplanes within that group, reflecting the "designated aeroplane configuration". It is recommended that the intended validation data together with a substantiation report be submitted to the NAA for evaluation and approval prior to the commencement of the manufacturing process.

2.4.3 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 aeroplane or class of aeroplanes being simulated. The models should be continuous and vary sensibly throughout the required training flight envelope. Additional data to refine the non type-specific model can be obtained from many sources, such as aeroplane design data, flight and maintenance manuals, observations on the ground and in the air, etc., without necessarily having to conduct expensive, 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, and new technologies (e.g. GPS).

2.4.4 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. There can be a strong interaction between the flight control forces and the effects of both the engines and the aerodynamic configuration. For this reason an active force feedback cueing system in which forces vary not only with position but with configuration (speed, flaps, trim) will be necessary for the representative "R" fidelity level of the flight controls and forces simulation feature. For the representative "R1" and 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. VISUAL SYSTEM

3.1 The emergence of lower-cost raster-only daylight systems is recognized for these types of devices. The adequacy of the performance of the visual system will be determined by its ability to support the intended training tasks, e.g. "visual cueing sufficient to support changes in approach path by using runway perspective".

3.2 For these types of devices, collimated visual optics are probably not necessary. A single channel direct viewing system would probably be acceptable as no training credits for landing will be available. Distortions due to non-collimation would only become significant during on ground or near to the ground operations. The risk in using that approach is that, should the device be subsequently upgraded to conduct training for multi-crew operations, the non-collimated visual system may be unacceptable.

3.3 Where the device does not simulate a particular aeroplane type, then the design of the out-of-cockpit/flight deck view should be matched to the visual system so that the pilot has a FOV sufficient for the intended training tasks. For example, during an instrument approach the pilot should be able to see the appropriate visual segment at decision height. Additionally, where the aeroplane deviates from the normal approach path, undue loss of visual reference should not occur during the subsequent correction.
4. SYSTEM INTEGRITY

4.1 For a non type-specific device, a transport delay test may be used to demonstrate that the FSTD system does not exceed the permissible delay. However, for such a device using simple models, a Statement of Compliance may be acceptable in lieu of a test.

4.2 The maximum permissible transport delays and tests to determine compliance with these requirements may be found in Attachment G of this Part.

5. TESTING/EVALUATION

5.1 To ensure that any device meets its design criteria initially and periodically throughout its life, a system of objective and subjective testing will be used.

5.2 The validation tests specified in Appendix B of this Part can be flown by a suitably skilled person and the results recorded manually. Bearing in mind the cost implications, the use of automatic recording and testing is encouraged thereby increasing the repeatability of the achieved results.

5.3 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 inspecting authority 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 regulatory inspection.

5.4 A number of tests within the QTG have had their tolerances reduced to “Correct Trend and Magnitude” (CT&M) thereby avoiding the need for specific validation data. 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 FSTD should be appropriate and representative of the simulated designated aeroplane and should under no circumstances exhibit negative characteristics. Where CT&M is used as a tolerance, it is strongly recommended that an automatic recording system be used to footprint the baseline results thereby avoiding the effects of possible divergent subjective opinions during recurrent evaluations.

5.5 Longitudinal change force tests. For the Type II and IV devices, it is acceptable to use change force tests instead of the longitudinal power, flap and gear change dynamics tests. The purpose of these change force tests is to simply reproduce the control force feeling during recurrent evaluations. However, if automatic testing is used, a change dynamics test is equally acceptable. If not otherwise stated, these tests should be conducted in the following way:

a) trim the aeroplane in straight and level flight in the most suitable configuration;
b) initiate the configuration change (power, flap or gear change);
c) maintain the airspeed constant using the pitch control (or as an alternate procedure, maintain the altitude of the original trimmed conditions); and
d) measure the required pitch control force change.

5.6 The subjective tests listed in Appendix C of 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 AEROPLANES

1. GENERAL POLICY

1.1 Except where specifically indicated otherwise within the Table of FSTD validation tests in Appendix B of this Part, validation data for QTG objective tests are expected to be derived from aeroplane flight tests.

1.2 Ideally, data packages for all new FSTDs will fully comply with the current standards for qualifying FSTDs.

1.3 For types of aeroplanes 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 of this Part, New aeroplane FSTD qualification).

1.4 For aeroplanes type-certificated prior to the release of the current amendment of NAA regulations, it may not always be possible to provide the required data for any new or revised objective test cases compared to the previous amendments. After prototype certification, manufacturers do not normally keep flight test aeroplanes 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 aeroplane will still be available.

1.5 Notwithstanding the above discussion, except where other types of data are acceptable (see, for example, Attachment B of this Part, Engineering simulation validation data), the preferred source of validation data is flight test. 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 during 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;

   b) data from an audited engineering simulation from an acceptable source (for example, meeting the guidelines laid out in Attachment B of this Part, Engineering simulation validation data), or as used for aircraft certification;

   c) aeroplane performance data published by the aircraft manufacturer in documents such as the aeroplane flight manual, operations manual, performance engineering manual or equivalent, or other approved published sources (e.g. production flight test schedule) for the following tests:

      1) 1.c (1) – Normal climb all engines operating;

      2) 1.c (2) – one-engine-inoperative 2nd segment climb;

      3) 1.c (3) – one-engine-inoperative en-route climb;
4) 1.c (4) – one-engine-inoperative approach climb for aeroplanes with icing accountability;

5) 1.e (3) – stopping distance, wheel brakes, wet runway; and

6) 1.e (4) – stopping distance, wheel brakes, icy runway; and
d) where no other data are available, then the following sources may be acceptable subject to a case-by-case review with the NAA concerned, taking into consideration the level of qualification sought for the FSTD:

1) unpublished but acceptable sources (e.g. calculations, simulations); or

2) footprint test data from the actual FSTD requiring qualification, validated by pilot subjective assessment.

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 a \( V_{m cg} \) test, where the flight test engine and thrust profile do not match the simulated engine. The \( V_{m cg} \) test could be run twice, once with the flight test thrust profile as an input and a second time with a fully integrated response to a fuel cut on the simulated engine.

1.7 For aeroplanes type-certificated prior to the date of issue 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.

1.8 These rationales should be clearly recorded within the validation data roadmap (VDR) in accordance with and as defined in Attachment D of this Part.

1.9 It should be recognized that there may come a time when there is so little compatible flight test data available that new flight test data may be required to be gathered.

### 2. RECOMMENDATION FOR THE USE OF FOOTPRINT TESTS

2.1 Only when all other alternative possible sources of data have been thoroughly sought without success may a footprint test be acceptable, 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 thrust rating);

b) a manoeuvre representative of the particular aeroplane being simulated;

c) the footprint test manoeuvre should be 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;
Part II. Flight Simulation Training Device Criteria

Attachment J. Applicability of national aviation authority regulation amendments

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e) an automatic test run as a fully integrated test with pilot input controls; and

f) automatically run for the initial qualification and recurrent evaluation.

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 (VDR) in accordance with and as defined in Attachment D of 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 and lowered. 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 take-off 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. 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 aeroplane instrument system which displays information to a pilot through a combiner in the normal “out-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 aeroplane. A block diagram describing the input and output signal flow and comparing it to the aeroplane configuration should support this statement.

2. FSTD/HUD STANDARDS

2.1 Whether the HUD system is an actual aeroplane 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 of this Part for additional information.

3.2 HUD systems that are software simulated (not being an actual aeroplane 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) Centreline 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.
GUIDANCE FOR THE QUALIFICATION OF AN FSTD ENHANCED FLIGHT VISION SYSTEM (EFVS)

1. APPLICABILITY

1.1 This procedure applies to all FSTDs with an enhanced flight vision system (EFVS) installation and is in addition to the head-up display (HUD) requirements detailed in Attachment K of this Part.

1.2 For the purpose of this document, “EFVS” will be used as a generic term for any alternative aeroplane visual enhancement aid, using imaging sensors, such as an infra-red radiometer or a radar, which displays information to a pilot through a HUD combiner glass in the normal “out-the-window” view.

1.3 This attachment details one means to evaluate and qualify an FSTD EFVS 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 an EFVS system should contain an EFVS statement of compliance (SOC). This statement should be an attestation that the EFVS hardware and software, including associated displays and annunciation, function in the same way or in an equivalent way to the system(s) installed in the aeroplane. A block diagram describing the input and output signal flow and comparing it to the aeroplane configuration should support this statement.

2. FSTD/EFVS STANDARDS

2.1 Whether the EFVS system is an actual aeroplane system, or is software simulated, the system should be shown to perform its intended function for each operation and phase of flight.

2.2 The FSTD requirements for qualifying an EFVS system in an FSTD are:

a) the EFVS FSTD hardware/software, including associated flight deck displays and annunciation, should function in the same or in an equivalent way to the EFVS system installed in the aeroplane;

b) an active display (repeater) of the pilot's combiner should be located on the instructor operating station (IOS), or at another location approved by the NAA. It should include a duplicate display of the EFVS and HUD scene, as seen through the pilot's HUD combiner glass or the cockpit flight displays; and

c) a minimum of one airport should be modelled for EFVS. That model should have an ILS and a non-precision approach (with VNAV if required by the AFM for that aeroplane type) available. In addition to EFVS modelling, the airport model should meet all other applicable visual requirements for that device.
3. OBJECTIVE TESTING

Both on-ground and flight tests are required for qualification. Computer-generated simulator test results should be provided for each test. The FSTD test results should be recorded on appropriate media acceptable to the NAA. Time histories are required unless otherwise indicated. See Appendix B of this Part for the specific test requirements.

4. SUBJECTIVE TESTING

4.1 Handling qualities, performance, and FSTD systems operation, while using the EFVS system, should be subjectively assessed.

4.2 The ground and flight tests and other checks required for qualification of the EFVS system are listed below. The evaluation should be conducted using daylight, dusk, and night conditions, daylight being the most difficult to simulate.

a) Pre-flight inspection of the EFVS system to include all EFVS warnings and annunciations.

b) Taxi:
   1) Parallax caused by sensor position.
   2) Ground hazards, especially other aircraft.
   3) Signs may appear as a block (unreadable) due to the absence of temperature variation between the letters and the background, with an infra-red sensor.

c) Take-off:
   1) Normal take-off in night visual meteorological conditions.
   2) Instrument take-off with visual system visibility set to enable an RVR of 180 m (600 ft).

d) In-flight operations:
   1) Image horizon should be conformal with the visual and combiner horizons.
   2) visual meteorological conditions night or dusk scene; a thunderstorm should be detected out to a distance of at least 37 km (20 NM).

e) Approaches:
   1) Normal approach in night visual meteorological conditions.
   2) ILS approach.
   3) Non-precision approach.
   4) Missed approach.

Note.— Emphasis should be placed on the FSTD’s capability to demonstrate that the EFVS system is able to display the required visual cues for the pilot to descend below the published decision height (DH). The HUD should continue to provide glide path and alignment information between DH and touchdown. During landing roll-out, visual alignment information should be available to the pilot through the HUD.
f) Visual segment and landing:
   1) From non-precision approach; and
   2) From precision approach.

g) Abnormal procedures:
   1) EFVS malfunctions on the ground; and
   2) EFVS malfunctions in the air.

h) Due to the uniqueness of this system and the normal simulator environmental visual selections, the IOS should have pre-set weather conditions for EFVS operations. Recommended settings are such that EFVS “visual” reference can be attained at approximately 150 m (500 ft) AGL, at CAT I and EFVS authorized minima, and below minima to force a go-around.
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 aeroplane 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 an aeroplane-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 flight deck that replicates all auto-flight functions of the aeroplane. 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 of this Part. There are no validation test requirements. The device is meant to be evaluated through the applicable tests of Appendix C of 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 aeroplane 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

<table>
<thead>
<tr>
<th>APP A #</th>
<th>REQUIREMENT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>COCKPIT/FLIGHT DECK STRUCTURE</td>
<td>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. The instruments displayed should be free of quantization (stepping). Aeroplane-like controls, instruments and equipment means corresponding to the aeroplane being simulated. If the FPTD is convertible, some may have to be changed for some conversions.</td>
</tr>
<tr>
<td>1.2</td>
<td>SEATING</td>
<td>Seats may be as simple as a regular chair.</td>
</tr>
<tr>
<td>1.3</td>
<td>COCKPIT/FLIGHT DECK LIGHTING</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>FLIGHT MODEL</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>The device is not required to fly, but, if applicable, aerodynamic and engine modelling should be broadly representative of the aeroplane being simulated and of sufficient fidelity to support the simulated systems (e.g. FMS and autopilot).</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>GROUND REACTIONS AND HANDLING CHARACTERISTICS</td>
<td>Not required.</td>
</tr>
<tr>
<td>APP A #</td>
<td>REQUIREMENT</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>---------</td>
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</tr>
<tr>
<td>4.</td>
<td>AEROPLANE SYSTEMS (ATA)</td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>NORMAL, ABNORMAL AND EMERGENCY SYSTEMS OPERATION</td>
<td>Aircraft systems represented in the FPTD should simulate the aeroplane system(s) operation including system interdependencies, both on the ground and in flight, as applicable. At least one aeroplane 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.</td>
</tr>
<tr>
<td>4.2</td>
<td>CIRCUIT BREAKERS</td>
<td>Circuit breakers required for any training event should be functionally representative of those in the aeroplane and the effects should be accurate. Circuit breaker panels, if provided, need not be spatially correctly located. Circuit breakers presented in a flat panel display should be considered as “functionally representative” towards procedural knowledge training credits (see Table M-2 below).</td>
</tr>
<tr>
<td>4.3</td>
<td>INSTRUMENT INDICATIONS</td>
<td>As or if applicable, any relevant instrument indications involved in the simulation of the aeroplane should automatically respond to control movement by a flight crew member or autoflight device including autopilot and auto-thrust systems. The device is not required to fly.</td>
</tr>
<tr>
<td>4.4</td>
<td>COMMUNICATIONS, NAVIGATION AND CAUTION AND WARNING SYSTEMS</td>
<td>If installed, communications, navigation, and caution and warning equipment should be aeroplane-like, with operation within the tolerances prescribed for the applicable equipment. As a minimum, aeroplane-like communications, navigation, and caution and warning equipment means corresponding to the aeroplane being simulated. If the FPTD is convertible, some equipment may have to be changed for some conversions.</td>
</tr>
<tr>
<td>5.</td>
<td>FLIGHT CONTROLS AND FORCES</td>
<td></td>
</tr>
<tr>
<td>5.3</td>
<td>CONTROL SYSTEM OPERATION</td>
<td>If installed, the flight control system should be aeroplane-like, and should allow basic aeroplane operation with appropriate resultant cockpit indications. Force feedback is not required. As a minimum, as per Appendix A, flight controls should have a “G” fidelity level, except that the controls should correspond to the aeroplane being simulated.</td>
</tr>
<tr>
<td>APP A #</td>
<td>REQUIREMENT</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>---------</td>
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<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>6.</td>
<td>SOUND CUES</td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>SOUND SYSTEM</td>
<td>If installed, any significant cockpit sounds simulated during normal and abnormal operations should be aeroplane-like, corresponding to the aeroplane being simulated, and may include engine and airframe sounds as well as those which result from pilot-induced or instructor-induced actions. As a minimum, as per Appendix A, sound cues should have a “G” fidelity level, except that the sound should be as for the aeroplane being simulated.</td>
</tr>
<tr>
<td>6.4</td>
<td>SOUND VOLUME</td>
<td>The volume control should have an indication of the sound level setting, to be accepted during the initial evaluation. If a sound system is installed.</td>
</tr>
<tr>
<td>7.</td>
<td>VISUAL DISPLAY CUE</td>
<td>Not required, but, if installed, the visual system should meet, as a minimum, the Appendices A, B and C of Part III, visual cue requirements for the “G” fidelity level.</td>
</tr>
<tr>
<td>8.</td>
<td>MOTION CUE</td>
<td>Not required.</td>
</tr>
<tr>
<td>9.</td>
<td>ENVIRONMENT – ATC (VOICE)</td>
<td>Not required, but if installed, the system should meet, as a minimum, the Appendices A, B and C of Part III environment – ATC requirements for the “G” fidelity level.</td>
</tr>
<tr>
<td>10.</td>
<td>ENVIRONMENT – NAVIGATION</td>
<td>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 without restriction. Navigational database should be maintained with regular updates, as mandated by the NAA for such a system.</td>
</tr>
<tr>
<td>13.</td>
<td>MISCELLANEOUS</td>
<td></td>
</tr>
<tr>
<td>13.2</td>
<td>INSTRUCTOR CONTROLS</td>
<td>Instructor controls for all required system variables, freezes, resets and for insertion of malfunctions to simulate abnormal or emergency conditions, as appropriate.</td>
</tr>
<tr>
<td>13.4</td>
<td>COMPUTER CAPACITY</td>
<td>Sufficient FPTD computer capacity, accuracy, resolution and dynamic response to fully support the overall FPTD fidelity needed to meet the qualification level sought.</td>
</tr>
<tr>
<td>13.6</td>
<td>UPDATES TO FPTD HARDWARE AND SOFTWARE</td>
<td>Timely permanent update of FPTD hardware and software subsequent to FPTD manufacturer recommendation where it affects training capability and/or safety.</td>
</tr>
</tbody>
</table>
**APP A #** | **REQUIREMENT** | **COMMENTS**
--- | --- | ---
13.7 | 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

<table>
<thead>
<tr>
<th>Event</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preparation for flight</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-flight</td>
<td></td>
<td>N</td>
<td></td>
</tr>
<tr>
<td><strong>APU/engine start and run-up</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine start:</td>
<td></td>
<td></td>
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<tr>
<td>Normal start</td>
<td></td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Alternate start procedures</td>
<td></td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Abnormal starts and shutdowns</td>
<td></td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Pushback</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td><strong>Thrust response</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Throttle lever functionality</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Brake operation (normal, alternate, emergency)</strong></td>
<td></td>
<td>N</td>
<td></td>
</tr>
<tr>
<td><strong>Brake fade (if applicable)</strong></td>
<td></td>
<td>N</td>
<td></td>
</tr>
<tr>
<td><strong>Take-off</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal operations:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine checks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceleration characteristics</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Nosewheel and rudder steering</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Event</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>----------------------------------------------------</td>
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</tr>
<tr>
<td>Effect of crosswind</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Special performance</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Instrument take-off</td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Gear, flap/slat operation</td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Abnormal/emergency operations:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rejected take-off</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Rejected special performance take-off</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Failure of critical engine at $V_1$</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Flight control system failure modes</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Wind shear</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Climb</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal climb</td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Engine(s) inoperative procedures</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Cruise</strong></td>
<td></td>
<td></td>
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<tr>
<td>Performance (speed versus power)</td>
<td></td>
<td></td>
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<tr>
<td>Turns with/without spoilers</td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>High altitude handling</td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>High speed handling</td>
<td></td>
<td></td>
<td>N</td>
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<tr>
<td>Mach effects on control and trim</td>
<td></td>
<td></td>
<td>N</td>
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<tr>
<td>Overspeed warning</td>
<td></td>
<td></td>
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<tr>
<td>Normal and steep turns</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Approach to stalls:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Cruise</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2) Take-off/approach</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>3) Landing</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>High angle of attack manoeuvres:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Cruise</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2) Take-off/approach</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>3) Landing</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>In-flight engine shutdown</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>In-flight engine restart</td>
<td>N</td>
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### Surface Operations (After Landing)

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### Aircraft and Engine Systems

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## Event

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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 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.

---

2. The rest position is defined as the position where the control 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 aeroplane configuration and the accelerations it is subjected to. It will depend on the type of flight control system in the aeroplane. 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.
3. TOLERANCES

The final alternate reference line (see Figure N-3) may be used to calculate the conventional tolerances described in Appendix B of 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
Attachment O

GUIDANCE FOR ENVIRONMENT — ATC

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 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 II and 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.
MANUAL OF CRITERIA FOR THE QUALIFICATION OF FLIGHT SIMULATION TRAINING DEVICES

Volume I
Aeroplanes

Part III
Flight Simulation Feature and Fidelity Level Criteria
Chapter 1

GLOSSARY OF TERMS, ABBREVIATIONS AND UNITS

1.1 GLOSSARY OF TERMS

The terms used in this Part of the Manual have the following meanings:

**Active force feedback.** In the context of a Flight Controls System, active force feedback indicates that the aeroplane control forces may have a dependency upon flight conditions.

**Additional engines/avionics.** An FSTD which has simulation of more than one engine/avionics fit.

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

  Note.— An example is the data used to generate Aeroplane Flight Manual (AFM) or Flight Planning and Cruise Control Manual (FPCCM) values.

**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.

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

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

**Alternate engines/avionics.** An FSTD which has simulation of a replacement engine/avionics fit.

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

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

  Note.— For additional guidance, see the guidance material in the Attachments to this Part of this manual and related reading material listed in Chapter 2, 2.3, of this Part.

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

**Approved use.** The ability to complete the training, testing or checking tasks as prescribed in this document.

**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.** An aeroplane manufacturer’s engineering simulator which has undergone a review by the appropriate NAA and been found to be an acceptable source of supplemental validation data.
**Automatic testing.** FSTD testing wherein all stimuli are under computer control.

**Bank.** Bank/roll angle (degrees).

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

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

**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 their use may be dependent on the outcome of the event, e.g. a step towards a licence issuance, a recurrent evaluation of competency.

**Class of aeroplane.** In relation to the classification of aeroplanes, means aeroplanes having similar operating characteristics.

**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 aeroplane (CCA).** An aeroplane where pilot inputs to the control surfaces are transferred and augmented via computers.

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

**Convertible FSTD.** An FSTD in which significant hardware, software, or a combination of both are changed so that the device becomes a replica of a different model, type or variant, usually, of the same aeroplane. The same FSTD platform, motion system, 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 necessary. Otherwise, supplemental section added to the original QTG may suffice.

**Correct trend and magnitude.** A tolerance meaning the appropriate general direction of movement of the aeroplane, 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 propulsive force 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.

**Daylight visual.** A visual system capable of meeting, as a minimum, the system brightness and contrast ratio requirements as identified in Appendix B.

**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 qualified to the same level.

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

**Engineering simulator validation data.** Validation data generated by an engineering simulation or engineering simulator that is 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 level 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.

**Flight simulation training device (FSTD).** A synthetic training device that is in compliance with the minimum requirements for FSTD qualification as described in this manual.

**FSTD approval.** Declaration of the extent to which an FSTD of a specified qualification level may be used by an operator or training organization as agreed by the NAA. It takes account of differences between aeroplanes 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 13 categories that have been used in Appendix A of Part III of this manual for the definition of the general and technical requirements for FSTDs.

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

**FSTD qualification level.** The level of technical capability of an FSTD.

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

**Flight test data.** Actual aeroplane data obtained by the aeroplane manufacturer (or other approved supplier of data) during an aeroplane flight test programme.

**Footprint test.** A test conducted and recorded on an FSTD to be used as reference.

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

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

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

**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 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 aeroplane under normal and non-normal conditions.

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

**Ground effect.** The change in aerodynamic characteristics due to modification of the airflow past the aeroplane, caused by proximity to the ground.

**Ground reaction.** Forces acting on the aeroplane due to contact with the ground. These forces should include the effects of strut deflections, tire friction, side forces, structural contact and other appropriate aspects. These forces should change appropriately, for example, with weight and speed.

**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.** Operating mass at or near the maximum for the specified flight condition.

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

**Highlight brightness.** The maximum displayed brightness.
Icing accountability. Refers to changes from normal (as applicable to the individual aeroplane design) in take-off, climb (en-route, approach, landing) or landing operating procedures or performance data, in accordance with the Aeroplane Flight Manual, for flight in icing conditions or with ice accumulation on unprotected surfaces.

Integrated testing. Testing of the FSTD such that all aeroplane system models are active and contribute appropriately to the results. None of the aeroplane system models should be substituted with models or other algorithms intended for testing purposes only. This 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.

International Committee for FSTD Qualification (ICFQ). A committee of the Royal Aeronautical Society that reviews proposals for updating this manual.

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

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

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

Light gross mass. A mass chosen by the sponsor or data provider that is not more than 120 per cent of the basic operating mass (BOM) of the aeroplane being simulated or as limited by the minimum practical operating mass of the test aeroplane.

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. Normal operating mass for the flight condition.

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

Near maximum gross mass. A mass chosen by the sponsor or data provider that is not less than the BOM of the aeroplane being simulated plus 80 per cent of the difference between the maximum certificated mass (either take-off mass or landing mass, as appropriate for the test) and the BOM.

Night visual. A visual system capable of producing, as a minimum, all features applicable to the twilight scene (see Twilight (dusk/dawn) visual) with the exception of the need to portray reduced ambient intensity which removes ground cues that are not self-illuminating or illuminated by own ship lights (e.g. landing lights).

Nominal. Normal operating 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 aeroplanes.

Note. — Specific terms such as alternate, direct, secondary or back-up, etc., may be used to define an actual level of degradation used in reference to computer-controlled aeroplanes.
**Normal control.** A state where the intended control, augmentation and protection functions are fully available. Used in reference to computer-controlled aeroplanes.

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

**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, passive force feedback indicates that the aeroplane control forces do not have a dependency upon flight conditions, e.g. the flight controls forces may be provided by a spring, or spring and damper arrangement.

**Protection functions.** Systems functions designed to protect an aeroplane 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 manual.

**Representative (R).** The intermediate level of required fidelity for a given FSTD feature.

**Reversible control system.** A control system in which movement of the control surface will back drive the pilot’s control on the flight deck.

**Second segment.** That portion of the take-off profile from after gear retraction to end of climb at V2 and the beginning of the acceleration segment (initial flap/slat retraction).

**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.

**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.

**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) on the flight deck, which also may be referred to as TLA or power lever angle or throttle angle.
**Time history.** The presentation of the change of a variable with respect to time.

**Train.** 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.** 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 aeroplane 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 aeroplane simulated.

**Twilight (dusk/dawn) visual.** A visual system capable of producing, as a minimum, full-colour presentations of reduced ambient intensity, sufficient surfaces with appropriate textural cues that include self-illuminated objects such as road networks, ramp lighting and airport signage.

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

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

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

**Validation data roadmap (VDR).** A document from the aeroplane 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 thrust rating and the revision levels of all avionics that affect aeroplane handling qualities and performance. See Attachment D to this manual.

**Validation flight test data.** Performance, stability and control, and other necessary test parameters, electrically or electronically recorded in an aeroplane using a calibrated data acquisition system of sufficient resolution and verified to be 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.

**Visual ground segment.** The visible distance on the ground, between the lower cut-off of the aeroplane cockpit and the furthest visible point, as limited by the prevailing visibility.
1.2 ABBREVIATIONS AND UNITS

The abbreviations and units used in Part III of this manual have the following meaning:

- $A_A$: 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)
- ACARS: Aircraft Communication Addressing and Reporting System
- AGL: Above Ground Level (m or ft)
- AOA: Angle of Attack (degrees)
- APU: Auxiliary Power Unit
- APV: Approach Procedures with Vertical guidance
- ASOS: Automated Surface Observation System
- ATA: Air Transport Association
- ATC: Air Traffic Control
- ATIS: Automatic Terminal Information System
- ATN: Aeronautical Telecommunication Network
- ATPL: Airline Transport Pilot Licence (Certificate or Type Rating)
- AWOS: Automated Weather Observing System
- 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
- CCA: Computer-Controlled Aeroplane
- CCD: Charge-Coupled Device
- cd/m²: Candela/metre² (3.4263 candela/m² = 1 ft-Lambert)
- CFIT: Controlled Flight Into Terrain
- cg: Centre of gravity
- cm: Centimetre(s)
- CPL: Commercial Pilot Licence
- CQ: Continuing Qualification
- CR: Class Rating
- ctd: continued
- CT&M: Correct Trend and Magnitude
- daN: DecaNewtons
- dB: Decibel
- dBSPL: Decibel, Sound Pressure Level
- DH: Decision Height
- DME: Distance Measuring Equipment
- DOF: Degrees of Freedom
- EASA: European Aviation Safety Agency
- EFIS: Electronic Flight Instrument System
- EFVS: Enhanced Flight Vision System
- EPR: Engine Pressure Ratio
- eQTG: Electronic Qualification Test Guide
- FAA: Federal Aviation Administration (United States of America)
- FANS: Future Air Navigation System
### Part III. Flight Simulation Feature and Fidelity Level Criteria

### Chapter 1. Glossary of terms, abbreviations and units

**FCL**  
Flight Crew Licensing

**FCOM**  
Flight Crew Operations Manual (or Operating Manual)

**FPCCM**  
Flight Planning and Cruise Control Manual

**FPTD**  
Flight Procedures Training Device

**FSTD**  
Flight Simulation Training Device

**FOV**  
Field of View

**ft**  
Foot (1 ft = 0.304 801 m)

**ft-Lambert**  
Foot-lambert (1 ft-Lambert = 3.426 3 candela/m²)

**G**  
Generic (as related to fidelity level)

**g**  
Acceleration due to gravity (m/s² or ft/s²; 1 g = 9.81 m/s² or 32.2 ft/s²)

**GBAS**  
Ground-Based Augmentation System

**GNSS**  
Global Navigation Satellite System

**GPS**  
Global Positioning System

**G/A**  
Go-Around

**G/S**  
Glide Slope

**HGS**  
Head-up Guidance System

**HUD**  
Head-up Display

**Hz**  
Unit of frequency (1 Hz = one cycle per second)

**IAS**  
Indicated Airspeed

**IATA**  
International Air Transport Association

**ICAO**  
International Civil Aviation Organization

**ILS**  
Instrument Landing System

**IO**  
Initial Operator training and checking

**IOS**  
Instructor Operating Station

**IPOM**  
Integrated Proof of Match

**IR**  
Initial Instrument Rating

**JAA**  
European Joint Aviation Authorities

**JAWS**  
Joint Airport Weather Studies

**km**  
Kilometre(s) (1 km = 0.621 37 statute mile)

**kPa**  
KiloPascal (kilonewton/m²) (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 = 4.448 2 newton)

**LOC/LLZ**  
ILS localizer

**LOC-BC**  
ILS localizer Back Course

**LOFT**  
Line-Oriented Flight Training

**LOS**  
Line-Oriented Simulation

**m**  
Metre(s) (1 m = 3.280 84 ft)

**MCQFSTD**  
Manual of Criteria for the Qualification of Flight Simulation Training Devices

**MCTM**  
Maximum Certificated Take-off Mass (kilos/pounds)

**MDA**  
Motion Drive Algorithm

**min**  
Minute(s)

**MLG**  
Main Landing Gear

**MLS**  
Microwave Landing System

**MPa**  
MegaPascals (1 psi = 6 894.76 pascals)

**MPL**  
Multi-crew Pilot Licence

---

**Note:** The abbreviations and units listed are those commonly used in aviation and flight simulation contexts. It is important to consult the specific manuals and guidelines from relevant aviation authorities for the most accurate and up-to-date information.
MQTG Master Qualification Test Guide
ms Millisecond(s)

N None (as related to fidelity level) or Normal control state referring to computer-controlled aeroplanes (depending on context)
n Sequential period of a full cycle of oscillation
N1 Low-pressure rotor revolutions per minute, expressed in per cent of maximum
N2 High-pressure rotor revolutions per minute, expressed in per cent of maximum
NAA National Aviation Authority
NDB Non-Directional Beacon
NM Nautical Mile (1 NM = 1 852 m = 6 076 ft)
NN Non-Normal control state referring to computer-controlled aeroplanes
NWA Nosewheel Angle (degrees)

OAT Outside Air Temperature
OMCT Objective Motion Cueing Test
OTD Other Training Device

P0 Time from 90 per cent of the initial controller displacement until initial X-axis crossing (X-axis defined by the resting amplitude)
P1 Period of first full cycle of oscillation after the initial X-axis crossing
P2 Period of second full cycle of oscillation after the initial X-axis crossing
Pf Impact or feel pressure
Pn Sequential period of oscillation
PANS Procedures for Air Navigation Services
PAPI Precision Approach Path Indicator system
PAR Precision Approach Radar
pitch Pitch angle (degrees)
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 Pounds per square inch (1 psi = 6.894 76 kPa)

QFE Altimeter setting related to a specific feature (e.g. airport)
QNH Altimeter setting related to Sea Level
QRH Quick Reference Handbook
QTG Qualification Test Guide

R Representative (as related to fidelity level)
RAE Royal Aerospace Establishment
RAeS Royal Aeronautical Society
RAT Ram Air Turbine
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 Recency (take off and landing)
REIL Runway End Identifier Lights
RL Recurrent Licence Training and Checking
RMS Root Mean Square
RNAV Area Navigation
RO Recurrent Operator Training and Checking
### Glossary of terms, abbreviations and units

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<th>Abbreviation</th>
<th>Description</th>
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<td>RPM</td>
<td>Revolutions per Minute</td>
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<td>RTO</td>
<td>Rejected Take-Off</td>
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<td>RVR</td>
<td>Runway Visual Range (m or ft)</td>
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<td>S</td>
<td>Specific (as related to fidelity level)</td>
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<td>s</td>
<td>Second(s)</td>
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<tr>
<td>SBAS</td>
<td>Satellite-Based Augmentation System</td>
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<tr>
<td>sm</td>
<td>Statute Mile(s) (1 statute mile = 1 609 m = 5 280 ft)</td>
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<tr>
<td>SMGCS</td>
<td>Surface Movement Guidance and Control System</td>
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<td>SOC</td>
<td>Statement of Compliance</td>
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<td>SPL</td>
<td>Sound Pressure Level</td>
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<td>SUPPS</td>
<td>Regional Supplementary Procedures</td>
</tr>
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<td>T</td>
<td>Train(ing)</td>
</tr>
<tr>
<td>T_t</td>
<td>Total time of the flare manoeuvre duration</td>
</tr>
<tr>
<td>T_i</td>
<td>Total time from initial throttle movement until a 10 per cent response of a critical engine parameter</td>
</tr>
<tr>
<td>T_t</td>
<td>Total time from initial throttle movement to a 90 per cent increase or decrease in the power level specified</td>
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<td>T(A)</td>
<td>Tolerance applied to amplitude</td>
</tr>
<tr>
<td>T(Ad)</td>
<td>Tolerance applied to residual amplitude</td>
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<td>TACAN</td>
<td>Tactical Air Navigation</td>
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<td>TBD</td>
<td>To Be Determined</td>
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<td>TCAS</td>
<td>Traffic alert and Collision Avoidance System</td>
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<td>TGL</td>
<td>Temporary Guidance Leaflet</td>
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<tr>
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<td>T(P)</td>
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</tr>
<tr>
<td>TR</td>
<td>Type Rating Training and Checking</td>
</tr>
<tr>
<td>TRG</td>
<td>Training</td>
</tr>
<tr>
<td>UTC</td>
<td>Coordinated Universal Time</td>
</tr>
<tr>
<td>V1</td>
<td>Decision speed</td>
</tr>
<tr>
<td>V2</td>
<td>Take-off safety speed</td>
</tr>
<tr>
<td>V_mca</td>
<td>Minimum control speed (air)</td>
</tr>
<tr>
<td>V_mcg</td>
<td>Minimum control speed (ground)</td>
</tr>
<tr>
<td>V_mcl</td>
<td>Minimum control speed (landing)</td>
</tr>
<tr>
<td>V_mo</td>
<td>Maximum operating speed</td>
</tr>
<tr>
<td>V_mu</td>
<td>Minimum unstick speed</td>
</tr>
<tr>
<td>V_r</td>
<td>Rotate speed</td>
</tr>
<tr>
<td>V_s</td>
<td>Stall speed or minimum speed in the stall</td>
</tr>
<tr>
<td>VASI</td>
<td>Visual Approach Slope Indicator system</td>
</tr>
<tr>
<td>VDR</td>
<td>Validation Data Roadmap</td>
</tr>
<tr>
<td>VFR</td>
<td>Visual Flight Rules</td>
</tr>
<tr>
<td>VGS</td>
<td>Visual Ground Segment</td>
</tr>
<tr>
<td>VHF</td>
<td>Very High Frequency</td>
</tr>
<tr>
<td>VOR</td>
<td>VHF Omnidirectional Radio Range</td>
</tr>
<tr>
<td>WAT</td>
<td>Weight, Altitude, Temperature</td>
</tr>
</tbody>
</table>
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 an aeroplane 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 aeroplanes also have encouraged broader use of advanced simulation. FSTDs can provide more in-depth training than can be accomplished in aeroplanes and provide a safe and suitable learning environment. Fidelity of modern FSTDs is sufficient to permit pilot assessment with assurance that the observed behaviour will transfer to the aeroplane. 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 manual. Part I of this document 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 document, or may be unique. Part III of the document provides the information to enable identification of the requirements and testing for such a new device.

2.2.3 The MPL content is preliminary and offers a means by which the device requirements may be satisfied but should not be treated as the only means by which the device requirements of an MPL programme may be met. The relevant text in this manual will be updated when the pertinent information from the completion of the MPL programmes implementation phase becomes available.

2.2.4 The summary matrix (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, 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 by an authorised body before it could be considered for the process used here. The terminology used in the table below for training type, device feature and level of fidelity of device feature is defined as follows:

2.2.4.1 Training types:

MPL1 Multi-crew Pilot Licence – Phase 1, Core flying skills;
MPL2 Multi-crew Pilot Licence – Phase 2, Basic;
MPL3 Multi-crew Pilot Licence – Phase 3, Intermediate;
MPL4 Multi-crew Pilot Licence – Phase 4, Advanced;
IR Initial Instrument Rating;
PPL Private Pilot Licence;
CPL Commercial Pilot Licence;
TR Type Rating training and checking;
ATPL Airline Transport Pilot Licence or Certificate;
CR Class Rating;
RL Recurrent Licence Training and Checking;
RO Recurrent Operator Training and Checking;
IO Initial Operator Training and Checking;
CQ Continuing Qualification; and
Re Recency (Take-off and Landing).

2.2.4.2 FSTD features:

Flight Deck Layout and Structure
Flight Model (Aerodynamics and Engine)
Ground Handling
Aeroplane Systems (ATA)
Flight Controls and Forces

Sound Cues
Visual Cues
Motion Cues

Environment (ATC)
Environment (Navigation)
Environment (Weather)
Environment (Airports and Terrain)

Miscellaneous - (Instructor Operating Station, etc.)

2.2.4.3 Device feature fidelity level:

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

For a detailed definition of S, R, G and N please refer to Chapter 1, Section 1.1, fidelity level.
2.2.5 Training codes:

2.2.5.1 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.

2.2.5.2 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 Example of a Δ (Delta) Device

Note.— Guidance on the qualification criteria determination process is contained in Part I, Chapter 3.

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>LICENCE OR TYPE OF TRAINING</th>
<th>DEVICE FEATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type V</td>
<td>ATPL/TR/IO/RO/RL</td>
<td>T</td>
</tr>
<tr>
<td>Training Type 1/ Training Task 1</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Training Type 1/ Training Task 2</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Training Type 1/ Training Task 3</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Training Type 2/ Training Task 1</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Training Type 2/ Training Task 2</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Training Type 2/ Training Task 3</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Type V Δ Roll Up Summary</td>
<td></td>
<td>R</td>
</tr>
</tbody>
</table>

2.2.6 Notes for the use of Table 2-1 to define the desired Δ (delta) device type:

2.2.6.1 Selection of a unique set of training tasks from Part I, 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. 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 2.2.6.3 and 2.2.6.4 below describe the
treatment of integrated feature fidelity levels for validation testing and functions and subjective testing.

2.2.6.2 Correlation of the new device feature fidelity signature against the information provided in Appendix A of
this Part will provide the necessary requirements for the $\Delta$ device type.

2.2.6.3 Correlation of the new device feature fidelity signature against the information provided in Appendix B of
this Part will provide the necessary validation tests for the $\Delta$ 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 of
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.

2.2.6.4 Correlation of the new device feature fidelity signature against the information provided in Appendix C of
this Part will provide the necessary functions and subjective tests for the $\Delta$ 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
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 of 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 under the heading "Applicability". For any new
device type created, an appropriate functions and subjectives test 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 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 VII.

2.2.6.5 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.

2.2.7 The FSTD general and technical requirements defined in Appendix A of 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 of
this Part are grouped by relevant device feature and fidelity level.

2.2.8 If considering using this process, the appropriate NAA should be consulted very early.

2.3 RELATED READING MATERIAL

2.3.1 Applicants seeking FSTD evaluation, qualification and approval for use of aeroplane FSTDs 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.

2.3.2 The related national and international documents which form the basis of the criteria set out in this manual
are:
Part III. Flight Simulation Feature and Fidelity Level Criteria
Chapter 2. Introduction III-2-5

ICAO

Annex 1 – Personnel Licensing, Amendment 167;
Doc 4444, Procedures for AirNavigation Services — Air Traffic Management (PANS-ATM); and

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


JAA

JAR-FSTD A, Aeroplane Flight Simulation Training Devices;
JAR-FSTD H, Helicopter Flight Simulation Training Devices;
JAR-STD 1H, 2H, 3H: Helicopter Flight Simulators, Flight Training Devices, Flight & Navigational Procedure Trainers; and
FCL TGL #7, Multi-crew Pilot Licence Training – Air Traffic Control Environment Simulation.

United Kingdom


United States

14 CFR FAR Part 60, Requirements for the Evaluation, Qualification & Maintenance of Flight Simulation Training Devices;
Advisory Circular 120-40B, Aeroplane Simulator Qualification;
Advisory Circular 120-40B, (International) Aeroplane Simulator Qualification;
Advisory Circular 120-45A, Aeroplane Flight Training Device Qualification;
Advisory Circular 120-63, Helicopter Simulator Qualification; and

2.3.3 Additional related documents are:

International Air Transport Association (IATA):
Flight Simulator Design and Performance Data Requirements, 6th Edition, 2000; and

Royal Aeronautical Society publications:

2.3.4 It is important to regularly monitor Regulatory Guidance Material on the NAA web sites to understand the latest regulatory opinion on new technology or practices.
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 level 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, the FSTD performance could not be verified in the time normally available for the authority 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 and its 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 oversight of the activities of the user of the FSTD can approve 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, climb, cruise, descent, approach and landing; all-weather operations; control checks; and pilot, flight engineer and instructor station functions checks. The motion, 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 of this Part and the functions and subjective tests in Appendix C. Validation tests are used to compare objectively FSTD and aeroplane data to ensure that they agree within specified tolerances. Functions tests are objective tests of systems using aeroplane documentation. Subjective tests provide a basis for evaluating the 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 in Volume I, Part II of this manual.

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 aeroplane type, the aeroplane manufacturer's validation flight test data is preferred. Data from other sources may be used, subject to the review and concurrence of the 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 in Volume I, Part II of this manual.
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 a class of aeroplane with the exception of aeroplane type specific FSTDs (sound and motion systems) where these evaluations are against aeroplane type specific data. For initial evaluation of FSTDs representing a class of aeroplane, the aeroplane manufacturer’s validation flight test data is preferred. Data from other sources may be used, subject to the review and concurrence of the NAA responsible for the qualification.

2.5.4.2.1 For motion and sound systems, 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 and sound systems.

2.5.4.2.3 Alternatively, the recurrent evaluation can be based on objective evaluation against MQTG results as described in Attachment H in Volume I, Part II of this manual.

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 aeroplane within the class of aeroplanes the FSTD is representing or it may be based on information from several aeroplanes within the class. 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 shall show that the proposed validation data are representative of the aeroplane or the class of aeroplanes modelled. This report may include flight test data, manufacturer’s design data, information from the aeroplane flight manual (AFM) 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 aeroplane programmes, the aeroplane manufacturer’s data, partially validated by flight test data, may be used in the interim qualification of the FSTD. However, the FSTD should be re-qualified following the release of the manufacturer’s data resulting from the type certification of the aeroplane. The re-qualification schedule should be as agreed by the NAA, the FSTD operator, the FSTD manufacturer and the aeroplane manufacturer. For additional information, refer to Attachment A in Part II of this document.

2.5.7 FSTD operators seeking initial or upgrade evaluation of an FSTD should be aware that performance and handling data for older aeroplanes may not be of sufficient quality to meet some of the test standards contained in this manual. 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.

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 manual.

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) aeroplane model and series or class, as applicable, being simulated;
      3) FSTD qualification level;
      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 a documented acceptance testing procedure covering cockpit layout, all simulated aeroplane 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) aeroplane model and series or class, 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) a minimum of three designated qualification scenes; and

13) 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 test;

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 this Part 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 this Part:

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 aeroplane 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 flight deck 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 aeroplane 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:

   a) be computer generated;

   b) be produced on an appropriate media acceptable to the authority conducting the test;

   c) be time histories unless otherwise indicated and:

      i) should plot for each test the list of recommended parameters contained in the *Aeroplane Flight Simulator Evaluation Handbook, Volume I* (see 2.3.2);

      ii) be clearly marked with appropriate time reference points to ensure an accurate comparison between FSTD and aeroplane;

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

      iv) 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”;

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

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

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

   g) have parameters with specified tolerances identified, with tolerance criteria and units given. Automatic flagging of “out-of-tolerance” situations is encouraged; and

   h) have incremental scales on graphical presentations that provide the resolution necessary for evaluation of the parameters shown in Appendix B of this Part.
13) Validation data.

a) 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;

b) Aeroplane 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

c) 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, and

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.

2.6.3 The QTG will provide the documented proof of compliance with the FSTD validation tests in Appendix B of this Part. FSTD test results should be labelled using terminology common to aeroplane parameters as opposed to computer software identifications. These results should be easily compared with the supporting data by employing overplotting or other acceptable means. For tests involving time histories, the overplotting of the FSTD data to aeroplane 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 After the initial evaluation, the MQTG is 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 (May 15th, 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 manual.

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

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 level; 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 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.

2.11.1.3 The request for evaluation should also include a statement that the FSTD has been thoroughly tested using a documented acceptance testing procedure covering cockpit layout, all simulated aeroplane 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 manual. The applicant should further certify that all the QTG tests for the requested qualification level have been satisfactorily conducted.

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 level. 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 level.

2.11.2.3 An **upgrade** is defined as the raising of the qualification level 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 level 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 only applicable when the operator requests a higher qualification level 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.

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 level.

2.11.4 **Moving an FSTD to a new 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 what amount 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 **Composition of an evaluation team**

2.11.5.1 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 type-qualified pilot.

2.11.5.2 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.

2.11.5.3 On an initial evaluation, the FSTD manufacturer and/or aeroplane manufacturer should have technical staff available to assist as required.

2.11.6 **FSTD qualification basis**

2.11.6.1 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.
2.11.6.2 The NAA having jurisdiction over the FSTD should establish the time interval required for the recurrent evaluation.

2.12 ADOPTION OF THIS MANUAL INTO THE REGULATORY FRAMEWORK

The application of this manual and amendments into the regulatory framework is the responsibility of the various National Aviation Authorities (NAA) through their regulatory documents such as 14 CFR Part 60, JAR-FSTD A or other equivalent document (see 2.3.2).

2.13 FUTURE UPDATES OF THIS MANUAL

Appendix D of Volume I, Part II, describes the process to be used for proposed future updates to this document.

2.14 EVALUATION HANDBOOKS

The Aeroplane Flight Simulator Evaluation Handbook, as amended, is 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 manual. This two-volume document can be obtained through the Royal Aeronautical Society (see 2.3.2).
Appendix A

REQUIREMENTS FOR FEATURE FIDELITY LEVELS

INTRODUCTION

This appendix describes the minimum feature fidelity level requirements leading to the qualification of an FSTD according to an agreed international process. The validation tests and functions and subjective tests listed in Appendices B and C of 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, such as gear modelling approach, coefficient of friction sources, etc.
## 1. REQUIREMENT — FLIGHT DECK LAYOUT AND STRUCTURE

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<th>1.</th>
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<td><strong>FEATURE GENERAL REQUIREMENT</strong></td>
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<td><strong>FLIGHT DECK LAYOUT AND STRUCTURE</strong></td>
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<td>FEATURE TECHNICAL REQUIREMENT</td>
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<tr>
<td>COCKPIT/FLIGHT DECK LAYOUT AND STRUCTURE</td>
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| 1.1.S.c An enclosed, full scale replica of the cockpit/flight deck of the aeroplane being simulated including all: structure and panels; primary and secondary flight controls; engine and propeller controls, as applicable; equipment and systems with associated controls and observable indicators; circuit breakers; flight instruments; navigation, communications and similar use equipment; caution and warning systems and emergency equipment. The tactile feel, technique, effort, travel and direction required to manipulate the preceding, as applicable, should replicate those in the aeroplane. As applicable, equipment for operation of the cockpit/flight deck windows should be included but the actual windows need not be operable. Additional required flight crew member duty stations and those bulkheads aft of the pilots' seats containing items such as switches, circuit breakers, supplementary radio panels, etc., to which the flight crew may require access during any event after pre-flight cockpit/flight deck preparation is complete, are also considered part of the cockpit/flight deck and should replicate the aeroplane. | ✓ |   |    |   | Fitted systems or functions not required as part of the training program 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/flight deck procedure(s), should function to the extent required to replicate the aeroplane during that procedure(s). Such systems or functions not supported in the simulation software should be identified on the FSTD information page. Bulkheads containing only items such as landing gear pin storage compartments, fire axes or extinguishers, spare light bulbs, aeroplane document pouches, etc. may be omitted. Any items required by the training program, including those required to complete the pre-flight checklist, should be available but may be relocated to a suitable location as near as possible to the original position. An accurate facsimile of emergency equipment items, such as a three dimensional model or a photograph, is acceptable provided the facsimile is modelled or is operational to the extent required by the training program. Fire axes and any similar purpose instruments should be only represented by a photograph or silhouette. Exceptions to this policy may be acceptable on a case by case basis following coordination with the respective NAA. Coordination should be concluded during the simulator design phase. Aeroplane cockpit/flight deck observer seats are not considered to be additional flight crew member duty stations and may be omitted. | (Continued next page) | (Continued next two pages)
### FEATURE TECHNICAL REQUIREMENT
#### COCKPIT/FLIGHT DECK LAYOUT AND STRUCTURE

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<tr>
<td>1.1.S.c (ctd)</td>
<td>Note.— The cockpit/flight deck, 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.</td>
<td>✓</td>
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<td>The use of electronically displayed images with physical overlay or masking for FSTD instruments and/or instrument panels is acceptable provided:</td>
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<td>– all instruments and instrument panel layouts are dimensionally correct with differences, if any, being imperceptible to the pilot;</td>
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<td>– instruments replicate those of the aeroplane including full instrument functionality and embedded logic;</td>
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<td>– instruments displayed are free of quantization (stepping);</td>
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<td>– instrument display characteristics replicate those of the aeroplane including: resolution, colours, luminance, brightness, fonts, fill patterns, line styles and symbology;</td>
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<td>– overlay or masking, including bezels and bugs, as applicable, replicates the aeroplane panel(s);</td>
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<td>– instrument controls and switches replicate and operate with the same technique, effort, travel and in the same direction as those in the aeroplane;</td>
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<td>– instrument lighting replicates that of the aeroplane and is operated from the FSTD control for that lighting and, if applicable, is at a level commensurate with other lighting operated by that same control;</td>
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<td>– as applicable, instruments should have faceplates that replicate those in the aeroplane; and</td>
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## FEATURE TECHNICAL REQUIREMENT
### COCKPIT/FLIGHT DECK LAYOUT AND STRUCTURE
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<td>MPL4, TR, ATPL, RO, IO, CQ, and RL.</td>
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<td>For Training (T):</td>
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<td>MPL4 and Re only:</td>
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<td>- the display image of any three dimensional instrument, such as an electro-mechanical instrument, should appear to have the same three-dimensional depth as the replicated instrument. The appearance of the simulated instrument, when viewed from any angle, should replicate that of the actual aeroplane instrument. Any instrument reading inaccuracy due to viewing angle and parallax present in the actual aeroplane instrument should be duplicated in the simulated instrument display image.</td>
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<td>FEATURE TECHNICAL REQUIREMENT COCKPIT/FLIGHT DECK LAYOUT AND STRUCTURE</td>
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| 1.1.R An enclosed, or perceived to be enclosed, spatially representative cockpit/flight deck of the aeroplane or class of aeroplanes being simulated including representative: primary and secondary flight controls; engine and propeller controls as applicable; systems and controls; circuit breakers; flight instruments; navigation and communications equipment; and caution and warning systems. The technique, effort, travel and direction required to manipulate the preceding, as applicable, should be representative of those in the aeroplane or class of aeroplanes. Note 1.— The cockpit/flight deck enclosure need only be representative of that in the aeroplane or those in the class of aeroplanes being simulated and should include windows. Note 2.— The enclosure need only extend to the aft end of the cockpit/flight deck. | ✓ | | | | FSTD instruments and/or instrument panels using electronically displayed images with physical overlay or masking and operable controls representative of those in the aeroplane are acceptable. The instruments displayed should be free of quantization (stepping).
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 class representative form, and be functionally accurate.
With the requirement for only a spatially representative cockpit/flight deck, the physical dimensions of the enclosure may be acceptable to simulate more than one aeroplane or class of aeroplanes in a convertible FSTD. Each FSTD conversion should be representative of the aeroplane or class of aeroplanes being simulated which may require some controls, instruments, panels, masking, etc. to be changed for some conversions.
For PPL, CPL and MPL1 (T) only:
If the FSTD is used for VFR training, it should be a representation of the aeroplane or class of aeroplanes comparable to the actual aeroplane used for flight training. |
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<th>FEATURE TECHNICAL REQUIREMENT</th>
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<td>COCKPIT/FLIGHT DECK LAYOUT AND STRUCTURE</td>
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<td>The assembled components should be compatible and function in a cohesive manner.</td>
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<td>1.1.G An open, enclosed or perceived to be enclosed cockpit/flight deck area with aeroplane-like primary and secondary flight controls; engine and propeller controls as applicable; equipment; systems; instruments; and associated controls, assembled in a spatial manner to resemble that of the aeroplane or class of aeroplanes being simulated. The flight instrument panel(s) position and crew member seats should provide the crew member(s) a representative posture at the controls and design eye position.</td>
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<td>FSTD 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).</td>
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<td>Note.— 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) a representative design eye position comparable to that of the actual aeroplane used for training.</td>
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<td>Only those circuit breakers used in a normal, abnormal or emergency procedure need to be presented, simulated in an aeroplane-like form, and be functionally accurate.</td>
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<td>Note.— Aeroplane-like controls, instruments and equipment means as for the aeroplane or class of aeroplanes being simulated. If the FSTD is convertible, some may have to be changed for some conversions.</td>
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<td>1.2 SEATING</td>
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<td>1.2.1.S Flight crew member seats should replicate those in the aeroplane being simulated.</td>
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<tr>
<td>1.2.1.R Flight crew member seats should represent those in the aeroplane being simulated.</td>
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<tr>
<td>1.2.1.G 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 aeroplane or class of aeroplanes.</td>
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<td>1.2.2.S.a</td>
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<td>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. The location of at least one of these observer seats should provide an adequate view of the pilots’ panels and forward windows.</td>
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<td>✓ For Training-to-Proficiency (TP): MPL4, TR, ATPL, RO, IO, CQ, and RL. For Training (T): MPL4 and Re only: The authority may consider options to this requirement based on unique cockpit/flight deck configurations. The seats need not represent those found in the aeroplane but 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. Both seats should be of adequate comfort for the occupant to remain seated for a two-hour training session.</td>
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<td>1.2.2.S.b</td>
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<td>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.</td>
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<td>✓ For Training (T): TR, ATPL, RL, RO and IO only: At least one observer seat should have a system to permit selective monitoring of all flight crew member and instructor communications.</td>
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<td>1.2.2.R</td>
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<td>In addition to the flight crew member seats, there should be an instructor station seat and two suitable seats for an observer and an authority inspector.</td>
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<tr>
<td>1.2.2.G In addition to the flight crew member seats, there should be an instructor station seat and two suitable seats for an observer and an authority inspector.</td>
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<td>1.3 COCKPIT/FLIGHT DECK LIGHTING</td>
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<td>1.3.S Cockpit/flight deck lighting should replicate that in the aeroplane.</td>
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<td>1.3.R Lighting environment for panels and instruments should be sufficient for the operation being conducted.</td>
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<tr>
<td>1.3.G Lighting environment for panels and instruments should be sufficient for the operation being conducted.</td>
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## 2. REQUIREMENT — FLIGHT MODEL

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<tr>
<td>2.S</td>
<td>Aerodynamic and engine modelling for all combinations of drag and thrust, including the effects of change in aeroplane attitude, sideslip, altitude, temperature, gross mass, centre of gravity location and configuration to support the approved use. Should address ground effect, mach effect, aeroelastic representations, non-linearities due to sideslip, effects of airframe icing, forward and reverse dynamic thrust effect on control surfaces. Realistic aeroplane mass properties, including mass, centre of gravity and moments of inertia as a function of payload and fuel loading should be implemented.</td>
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<td>2.R</td>
<td>Aerodynamic, engine and ground reaction modelling, aeroplane-like, derived from and appropriate to class to support the approved use. Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight corresponding to actual flight conditions, including the effect of change in aeroplane attitude, sideslip, thrust, drag, altitude, temperature.</td>
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<td>FEATURE GENERAL REQUIREMENT FLIGHT MODEL</td>
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<td>2.G</td>
<td>Aerodynamic and engine modelling, aeroplane-like, not specific to class, model, type or variant to support the approved use. Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight corresponding to actual flight conditions, including the effect of change in aeroplane attitude, sideslip, thrust, drag, altitude, temperature.</td>
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<td>FEATURE TECHNICAL REQUIREMENT</td>
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<td><strong>FLIGHT MODEL</strong></td>
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<td><strong>2.1</strong> FLIGHT DYNAMICS MODEL</td>
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<td>2.1.S.a Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight supported by type-specific flight test data, including the effect of change in aeroplane attitude, sideslip, thrust, drag, altitude, temperature, gross mass, moments of inertia, centre of gravity location and configuration to support the intended use.</td>
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<td>2.1.S.b Aerodynamic modelling, that includes, for aeroplanes issued an original type certificate after 30 June 1980, Mach effect, normal and reverse dynamic thrust effect on control surfaces, aeroelastic effect and representations of non-linearities due to side-slip based on aeroplane flight test data provided by the aeroplane manufacturer.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>SOC required. Mach effect, aeroelastic representations and non-linearities due to side-slip are normally included in the flight simulator aerodynamic model. The SOC should address each of these items. Separate tests for thrust effects and an SOC are required.</td>
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<tr>
<td>2.1.S.c Aerodynamic modelling to include ground effect derived from type-specific flight test data. For example: round-out, flare and touchdown. This requires data on lift, drag, pitching moment, trim and power in ground effect.</td>
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<td></td>
<td>✓</td>
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<td>SOC required. See Appendix B, paragraph 3.3 and test 2.f for further information on ground effect.</td>
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<td>2.1.S.d Aerodynamic modelling for the effects of reverse thrust on directional control.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>Tests required. See Appendix B, tests 2.e.8 and 2.e.9 (directional control).</td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
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<tr>
<td><strong>2.1.S.e</strong> Modelling that includes the effects of icing, where appropriate, on the airframe, aerodynamics and the engine(s). Icing models should simulate the aerodynamic degradation effects of ice accretion on the aeroplane lifting surfaces including loss of lift, decrease in stall angle of attack, change in pitching moment, decrease in control effectiveness, and changes in control forces in addition to any overall increase in drag or aeroplane gross weight.</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>SOC should be provided describing the effects which provide training in the specific skills required for recognition of icing phenomena and execution of recovery. SOC should include verification that these effects have been tested. Icing effects simulation models are only required for those aeroplanes authorized for operations in icing conditions. Icing simulation models should be developed to provide training in the specific skills required for recognition of ice accumulation and execution of the required response.</td>
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<tr>
<td><strong>2.1.R</strong> Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight, including the effect of change in aeroplane attitude, sideslip, thrust, drag, altitude, temperature, gross weight, moments of inertia, centre of gravity location and configuration.</td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td><strong>2.1.G</strong> Modelling, aeroplane-like, not specific to class, model, type or variant. Flight dynamics model that accounts for various combinations of drag and thrust normally encountered in flight and supported by aeroplane generic data, including the effect of change in aeroplane attitude, sideslip, thrust, drag, altitude, temperature, gross weight, moments of inertia, centre of gravity location, and configuration.</td>
<td>✓</td>
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<tr>
<td>FLIGHT MODEL</td>
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<tr>
<td>2.2</td>
<td>MASS PROPERTIES</td>
<td></td>
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<tr>
<td>2.2.S</td>
<td>Type-specific implementation of aeroplane mass properties, including mass, centre of gravity and moments of inertia as a function of payload and fuel loading. The effects of pitch attitude and of fuel slosh on the aircraft centre of gravity should be simulated.</td>
<td>✔</td>
<td>SOC required. SOC should include a range of tabulated target values to enable a demonstration of the mass properties model to be conducted from the instructor's station. The SOC should include the effects of fuel slosh on centre of gravity.</td>
<td></td>
</tr>
<tr>
<td>2.2.R</td>
<td>N/A.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2.2.G</td>
<td>N/A.</td>
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### 3. REQUIREMENT — GROUND REACTION AND HANDLING CHARACTERISTICS

<table>
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<tr>
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<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>3.S</td>
<td>Represents ground reaction and handling characteristics of the aeroplane during surface operations to support the approved use. Brake and tire failure dynamics (including antiskid) and decreased brake efficiency should be specific to the aeroplane simulated. Stopping and directional control forces should be representative for all environmental runway conditions.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>3.R</td>
<td>Represents ground reaction and handling, aeroplane-like, derived from and appropriate to class.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
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</tr>
<tr>
<td>3.G</td>
<td>Represents ground reaction, aeroplane-like, derived from and appropriate to class. Simple aeroplane-like ground reactions, appropriate to the aeroplane geometry and mass.</td>
<td>✓</td>
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<td>FEATURE TECHNICAL REQUIREMENT</td>
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<td>GROUND REACTION AND HANDLING CHARACTERISTICS</td>
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<td>3.1</td>
<td>GROUND REACTION AND HANDLING CHARACTERISTICS</td>
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</tr>
<tr>
<td>3.1.S</td>
<td>Aeroplane type-specific ground handling simulation to include:</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>SOC required. Tests required.</td>
</tr>
<tr>
<td></td>
<td>(1) Ground reaction. Reaction of the aeroplane upon contact with the runway during take-off, landing and ground operations to include strut deflections, tire friction, side forces and other appropriate data, such as weight and speed, necessary to identify the flight condition and configuration; and</td>
<td></td>
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<td></td>
<td>(2) Ground handling characteristics. Steering inputs to include crosswind, braking, thrust reversing, deceleration and turning radius.</td>
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<tr>
<td>3.1.R</td>
<td>Representative aeroplane ground handling simulation to include:</td>
<td></td>
<td>✓</td>
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</tr>
<tr>
<td></td>
<td>(1) Ground reaction. Reaction of the aeroplane upon contact with the runway during take-off, landing and ground operations to include strut deflections, tire friction, side forces and other appropriate data, such as weight and speed, necessary to identify the flight condition and configuration; and</td>
<td></td>
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<tr>
<td></td>
<td>(2) Ground handling characteristics. Steering inputs to include crosswind, braking, thrust reversing, deceleration and turning radius.</td>
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</tr>
<tr>
<td>3.1.G</td>
<td>Generic ground reaction and ground handling models to enable touchdown effects to be reflected by the sound and visual systems.</td>
<td>✓</td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
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<tr>
<td>3.2 RUNWAY CONDITIONS</td>
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<tr>
<td>3.2.S Stopping and directional control forces for at least the following runway conditions based on aeroplane related data:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓ SOC required. Objective tests required for (1), (2) and (3). See Appendix B, tests 1.e (stopping). Subjective tests for (4), (5) and (6). See Appendix C.</td>
<td></td>
</tr>
<tr>
<td>(1) dry;</td>
<td></td>
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<tr>
<td>(2) wet;</td>
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<tr>
<td>(3) icy;</td>
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<td>(4) patchy wet;</td>
<td></td>
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<tr>
<td>(5) patchy icy; and</td>
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<tr>
<td>(6) wet on rubber residue in touchdown zone.</td>
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<tr>
<td>3.2.R Stopping and directional control forces should be representative for at least the following runway conditions based on aeroplane related data:</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>(1) dry; and</td>
<td></td>
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<tr>
<td>(2) wet.</td>
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<tr>
<td>3.2.G Stopping and directional control forces for a dry runway conditions.</td>
<td>✓</td>
<td></td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
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<td>GROUND REACTION AND HANDLING CHARACTERISTICS</td>
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<tr>
<td>BRAKE AND TIRE FAILURES</td>
<td>3.3</td>
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<tr>
<td>3.3.S</td>
<td>Brake and tire failure dynamics (including anti-skid) and decreased braking efficiency due to brake temperatures.</td>
<td></td>
<td></td>
<td>✓</td>
<td>SOC required. Subjective tests required for decreased braking efficiency due to brake temperature, if applicable.</td>
<td></td>
</tr>
<tr>
<td>3.3.R</td>
<td>N/A.</td>
<td></td>
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<tr>
<td>3.3.G</td>
<td>N/A.</td>
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### 4. REQUIREMENT — AEROPLANE SYSTEMS (ATA)

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<th>COMMENTS</th>
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<tbody>
<tr>
<td>4.S</td>
<td>Aeroplane systems should be replicated with sufficient functionality for flight crew operation to support the approved use. System functionality should enable all normal, abnormal, and emergency operating procedures to be accomplished. To include communications, navigation, caution and warning equipment corresponding to the aeroplane. Circuit breakers required for operations should be functional.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>4.R</td>
<td>Aeroplane systems should be replicated with sufficient functionality for flight crew operation to support the approved use. System functionality should enable sufficient normal and appropriate abnormal and emergency operating procedures to be accomplished.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>4.G</td>
<td>N/A.</td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT AEROPLANE SYSTEMS (ATA)</td>
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<tr>
<td>4.1 NORMAL, ABNORMAL AND EMERGENCY SYSTEMS OPERATION</td>
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<tr>
<td>4.1.S All aeroplane systems represented in the FSTD should simulate the specific aeroplane type system 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.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>Aeroplane system operation should be predicated on, and traceable to, the system data supplied by either the aeroplane manufacturer, original equipment manufacturer or alternative approved data for the aeroplane system or component. 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.</td>
<td></td>
</tr>
<tr>
<td>4.1.R Aeroplane systems represented in the FSTD should simulate representative aeroplane system operation including system interdependencies, both on the ground and in flight. Systems should be operative to the extent that appropriate normal, abnormal and emergency operating procedures can be accomplished.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>Aeroplane system operation should be predicated on, and traceable to, the system data supplied by either the aeroplane manufacturer, original equipment manufacturer or alternative approved data for the aeroplane system or component. 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.</td>
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<tr>
<td>4.1.G N/A.</td>
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<tr>
<td>4.2 CIRCUIT BREAKERS</td>
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<tr>
<td>4.2.S Circuit breakers that affect procedures and/or result in observable cockpit/flight deck indications should be functionally accurate.</td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>4.2.R Circuit breakers that affect procedures and/or result in observable cockpit/flight deck indications should be functionally accurate.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>Applicable if circuit breakers fitted.</td>
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<tr>
<td>4.2.G N/A.</td>
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<td>FEATURE TECHNICAL REQUIREMENT</td>
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<tr>
<td>AEROPLANE SYSTEMS (ATA)</td>
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<tr>
<td>4.3 INSTRUMENT INDICATIONS</td>
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<tr>
<td>4.3.S All relevant instrument indications involved in the simulation of the aeroplane should automatically respond to control movement by a flight crew member or to atmospheric disturbance and also respond to effects resulting from icing.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>Numerical values should be presented in the appropriate units.</td>
<td></td>
</tr>
<tr>
<td>4.3.R All relevant instrument indications involved in the class of aeroplanes simulated should automatically respond to control movement by a flight crew member or to atmospheric disturbance and also respond to effects resulting from icing.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>Numerical values should be presented in the appropriate units.</td>
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<tr>
<td>4.3.G N/A.</td>
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<tr>
<td>4.4 COMMUNICATIONS, NAVIGATION AND CAUTION AND WARNING SYSTEMS</td>
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<tr>
<td>4.4.S Communications, navigation, and caution and warning equipment corresponding to that installed in a specific aeroplane type should operate within the tolerances prescribed for the applicable airborne equipment.</td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>4.4.R Communications, navigation, and caution and warning equipment corresponding to that typically installed in a representative aeroplane simulation should operate within the tolerances prescribed for the applicable airborne equipment.</td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>4.4.G N/A.</td>
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### Part III. Flight Simulation Feature and Fidelity Level Criteria

### Appendix A. Requirements for feature fidelity levels

<table>
<thead>
<tr>
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<th>COMMENTS</th>
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<tr>
<td>4.5 ANTI-ICING SYSTEMS</td>
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<tr>
<td>4.5.S Operation of anti-icing systems corresponding to those installed in the specific aeroplane type should operate with appropriate effects upon ice formation on airframe, engines and instrument sensors.</td>
<td></td>
<td></td>
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<td>✓</td>
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</tr>
<tr>
<td>4.5.R Anti-icing systems corresponding to those typically installed in that class of aeroplanes should be operative.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>4.5.G N/A.</td>
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</table>
### 5. REQUIREMENT — FLIGHT CONTROLS AND FORCES

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<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>
| 5.S | Control forces and control travel should correspond to that of the aeroplane to support the approved use.  
Control displacement should generate the same effect as the aeroplane under the same flight conditions.  
Control feel dynamics should replicate the aeroplane simulated. | | | ✓ | | |
| 5.R | Aeroplane-like, derived from class, appropriate to aeroplane mass to support the approved use.  
Active force feedback required. | | | ✓ | | |
| 5.R1 | Aeroplane-like, derived from class, appropriate to aeroplane mass to support the approved use.  
Active force feedback not required. | | | ✓ | For MPL1 (T) only. |
| 5.G | Aeroplane-like to support the approved use.  
Active force feedback not required. | | | ✓ | | |
<table>
<thead>
<tr>
<th>FEATURE TECHNICAL REQUIREMENT</th>
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<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Control Forces and Travel</td>
<td></td>
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<td>Testing of position versus force is not applicable if forces are generated solely by use of aeroplane hardware in the FSTD.</td>
</tr>
<tr>
<td>5.1.S Control forces, control travel and surface position should correspond to that of the type-specific aeroplane being replicated. Control travel, forces and surfaces should react in the same manner as in the aeroplane under the same flight and system conditions.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>Active Force feedback required if appropriate to the aeroplane installation.</td>
</tr>
<tr>
<td>5.1.R Control forces, control travel and surface position should correspond to that of the aeroplane or class of aeroplanes being simulated. Control travel, forces and surfaces should react in the same manner as in the aeroplane or class of aeroplanes under the same flight and system conditions.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>Active Force feedback required if appropriate to the aeroplane installation.</td>
</tr>
<tr>
<td>5.1.R1 Control forces, control travel and surface position should correspond to that of the aeroplane or class of aeroplanes being simulated. Control surfaces should react in the same manner as in the aeroplane or class of aeroplanes under the same flight and system conditions, but control travel and forces should broadly correspond to the aeroplane or class of aeroplanes simulated.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Active Force feedback not required. For MPL1 (T) only.</td>
</tr>
<tr>
<td>5.1.G Control forces, control travel and surface position should broadly correspond to the aeroplane or class of aeroplanes simulated.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Active Force feedback not required. Control forces produced by a passive arrangement are acceptable.</td>
</tr>
<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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<tr>
<td><strong>FLIGHT CONTROLS AND FORCES</strong></td>
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<tr>
<td>5.2</td>
<td>CONTROL FEEL DYNAMICS</td>
<td></td>
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<tr>
<td>5.2.S</td>
<td>Control feel dynamics should replicate the aeroplane simulated.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>5.2.R</td>
<td>N/A.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2.G</td>
<td>N/A.</td>
<td></td>
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</tr>
<tr>
<td>5.3</td>
<td>CONTROL SYSTEM OPERATION</td>
<td></td>
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</tr>
<tr>
<td>5.3.S</td>
<td>Control systems should replicate aeroplane 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.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>5.3.R, R1</td>
<td>Control systems should replicate the class of aeroplanes 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.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>See Appendix C of this Part for applicable testing.</td>
</tr>
<tr>
<td>5.3.G</td>
<td>Control systems should allow basic aeroplane operation with appropriate cockpit indications.</td>
<td>✓</td>
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</table>
### 6. REQUIREMENT — SOUND CUES

<table>
<thead>
<tr>
<th></th>
<th>FEATURE GENERAL REQUIREMENT SOUND CUES</th>
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<th>R</th>
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<tr>
<td>6.S</td>
<td>N/A.</td>
<td></td>
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<tr>
<td>6.R</td>
<td>Significant sounds perceptible to the flight crew during flight operations to support the approved use. &lt;br&gt;Comparable engine, airframe and environmental sounds. &lt;br&gt;The volume control should have an indication of sound level setting.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>6.G</td>
<td>Significant sounds perceptible to the flight crew during flight operations to support the approved use. &lt;br&gt;Comparable engine and airframe sounds. &lt;br&gt;The volume control should have an indication of sound level setting.</td>
<td></td>
<td></td>
<td>✓</td>
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<td></td>
</tr>
<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
<td>SOUND CUES</td>
<td>G</td>
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<td>R</td>
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<td>COMMENTS</td>
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<tr>
<td>6.1</td>
<td>SOUND SYSTEM</td>
<td></td>
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<tr>
<td>6.1.R</td>
<td>Significant cockpit/flight deck sounds during normal and abnormal operations corresponding to those of the aeroplane, including engine and airframe sounds as well as those which result from pilot or instructor-induced actions.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>SOC required. Tests required. See Appendix B.</td>
</tr>
<tr>
<td>6.1.G</td>
<td>Significant cockpit/flight deck sounds during normal and abnormal operations, aeroplane class-like, including engine and airframe sounds as well as those which result from pilot or instructor-induced actions.</td>
<td>✓</td>
<td></td>
<td></td>
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<td>SOC required.</td>
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<tr>
<td>6.2</td>
<td>CRASH SOUNDS</td>
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<tr>
<td>6.2.R</td>
<td>The sound of a crash when the simulated aeroplane exceeds limitations.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2.G</td>
<td>The sound of a crash when the simulated aeroplane exceeds limitations.</td>
<td>✓</td>
<td></td>
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<tr>
<td>6.3</td>
<td>ENVIRONMENTAL SOUNDS</td>
<td></td>
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<tr>
<td>6.3.R</td>
<td>Significant environmental sounds should be coordinated with the simulated weather.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>6.3.G</td>
<td>Environmental sounds are not required. However, if present, they should be coordinated with the simulated weather.</td>
<td>✓</td>
<td></td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
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<tr>
<td>SOUND CUES</td>
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<tr>
<td>6.4 SOUND VOLUME</td>
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<tr>
<td>6.4.R The volume control should have an indication of sound level setting which meets all qualification requirements.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>The abnormal setting should consist of an annunciation on a main IOS page which is always visible to the instructor.</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
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</tr>
<tr>
<td>6.4.G The volume control should have an indication of sound level setting which meets all qualification requirements.</td>
<td>✓</td>
<td></td>
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<tr>
<td>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.</td>
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<tr>
<td>6.5 SOUND DIRECTIONALITY</td>
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<tr>
<td>6.5.R Sound should be directionally representative.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>SOC required.</td>
<td></td>
</tr>
<tr>
<td>6.5.G Sound not required to be directional.</td>
<td>✓</td>
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</table>
7. REQUIREMENT — VISUAL DISPLAY CUE

<table>
<thead>
<tr>
<th>7.</th>
<th>FEATURE GENERAL REQUIREMENT VISUAL DISPLAY CUE</th>
<th>G</th>
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<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.S</td>
<td>Continuous field of view with infinity perspective and textured representation of all ambient conditions for each pilot, to support the approved use. Horizontal and vertical field of view to support the most demanding manoeuvres requiring a continuous view of the runway. A minimum of 200 degrees horizontal and 40 degrees vertical field of view.</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>✓</td>
</tr>
<tr>
<td>7.R</td>
<td>Continuous field of view with textured representation of all ambient conditions for each pilot, to support the approved use. Horizontal and vertical field of view to support the most demanding manoeuvres requiring a continuous view of the runway. A minimum of 200 degrees horizontal and 40 degrees vertical field of view.</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>✓</td>
</tr>
<tr>
<td>7.G</td>
<td>A textured representation of appropriate ambient conditions, to support the approved use. Horizontal and vertical field of view to support basic instrument flying and transition to visual from straight-in instrument approaches.</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>✓</td>
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</table>
### FEATURE TECHNICAL REQUIREMENT

<table>
<thead>
<tr>
<th>VISUAL CUES</th>
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<th>R1</th>
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<th>S</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>7.1 DISPLAY</td>
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<tr>
<td>7.1.1 DISPLAY GEOMETRY AND FIELD OF VIEW</td>
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</tbody>
</table>
| 7.1.1.S Continuous, cross-cockpit, collimated visual display providing each pilot with a minimum 200 degrees horizontal and 40 degrees vertical field of view. The system should be free from optical discontinuities and artefacts that create non-realistic cues. | ✓ |    |    |   | See Appendix B – Test 4.a.1.  
An SOC is acceptable in place of this test.  

**Note.**—*Where the training task includes circling approaches with the landing on the reciprocal runway, a visual field of view in excess of 200 degrees horizontal and 40 degrees vertical would probably be required. Until such time as this becomes feasible the current arrangements in place with individual NAAs regarding approval for conducting specific circling approaches on a particular FSTD remain in place.* |
| 7.1.1.R Continuous visual field of view providing each pilot with 200 degrees horizontal and 40 degrees vertical field of view. | ✓ |    |    |   | See Appendix B – Test 4.a.1.  
Collimation is not required but parallax effects should be minimized (not greater than 10 degrees for each pilot when aligned for the point midway between the left and right seat eyepoints).  
The system should have the capability to align the view to the pilot flying.  

**Note.**—*Larger fields of view may be required for certain training tasks. The FOV should be agreed with the NAA.*  
Installed alignment should be confirmed in an SOC. (This would generally be results from acceptance testing). |
<table>
<thead>
<tr>
<th>FEATURE TECHNICAL REQUIREMENT</th>
<th>VISUAL CUES</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>
| 7.1.1.G                      | A field of view of a minimum of 45 degrees horizontally and 30 degrees vertically, unless restricted by the type of aeroplane, simultaneously for each pilot. 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. | ✓ | | | | See Appendix B – Test 4.a.1. 
<p>|                              |             |   |    |   |   | Collimation is not required. |
| 7.1.2 DISPLAY RESOLUTION     |             |   |    |   |   |          |
| 7.1.2.S                      | Display 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 eye point. | | ✓ | | | SOC required containing calculations confirming resolution. See Appendix B – Test 4.a.3. |
| 7.1.2.R                      | Display 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 eye point. | | ✓ | | | SOC required containing calculations confirming resolution. See Appendix B – Test 4.a.3. |
| 7.1.2.G                      | Adequate resolution to support the intended use. | ✓ | | | | |
| 7.1.3 LIGHT-POINT SIZE       |             |   |    |   |   |          |
| 7.1.3.S                      | Light-point size — not greater than 5 arc minutes. | | ✓ | | | SOC required confirming test pattern represents lights used for airport lighting. See Appendix B – Test 4.a.4. |
| 7.1.3.R                      | Light-point size — not greater than 8 arc minutes. | | ✓ | | | SOC required confirming test pattern represents lights used for airport lighting. See Appendix B – Test 4.a.4. |
| 7.1.3.G                      | Suitable to support the intended use. | ✓ | | | | |</p>
<table>
<thead>
<tr>
<th>FEATURE TECHNICAL REQUIREMENT VISUAL CUES</th>
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<th>R1</th>
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<th>COMMENTS</th>
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<tbody>
<tr>
<td>7.1.4 DISPLAY CONTRAST RATIO</td>
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<tr>
<td>7.1.4.S Display contrast ratio — not less than 5:1.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.a.5.</td>
</tr>
<tr>
<td>7.1.4.R Display contrast ratio — not less than 5:1.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.a.5.</td>
</tr>
<tr>
<td>7.1.4.G Suitable to support the intended use.</td>
<td></td>
<td>✓</td>
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<tr>
<td>7.1.5 LIGHT-POINT CONTRAST RATIO</td>
<td></td>
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<tr>
<td>7.1.5.R Light-point contrast ratio — not less than 10:1.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.a.6.</td>
</tr>
<tr>
<td>7.1.5.G Suitable to support the intended use.</td>
<td></td>
<td>✓</td>
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<tr>
<td>7.1.6 LIGHT-POINT BRIGHTNESS</td>
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<tr>
<td>7.1.6.S Light-point brightness – not less than 30 cd/m² (8.8 foot-lamberts).</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.a.7.</td>
</tr>
<tr>
<td>7.1.6.R Light-point brightness – not less than 20 cd/m² (5.8 foot-lamberts).</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.a.7.</td>
</tr>
<tr>
<td>7.1.6.G Suitable to support the intended use.</td>
<td></td>
<td>✓</td>
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<tr>
<td>7.1.7 DISPLAY BRIGHTNESS</td>
<td></td>
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<tr>
<td>7.1.7.S Display brightness should be demonstrated using a raster drawn test pattern. The surface brightness should not be less than 20 cd/m² (5.8 foot-lamberts).</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.a.8.</td>
</tr>
<tr>
<td>7.1.7.R Display brightness should be demonstrated using a raster drawn test pattern. The surface brightness should not be less than 14 cd/m² (4.1 foot-lamberts).</td>
<td></td>
<td>✓</td>
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<tr>
<td>7.1.7.G Suitable to support the intended use.</td>
<td></td>
<td>✓</td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
<td>VISUAL CUES</td>
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<tr>
<td>7.1.8</td>
<td>BLACK LEVEL AND SEQUENTIAL CONTRAST <em>(Light valve systems only)</em></td>
<td></td>
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<tr>
<td>7.1.8.S</td>
<td>The black level and sequential contrast need to be measured to determine it is sufficient for training in all times of day.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7.1.8.R</td>
<td>Suitable to support the intended use.</td>
<td>✓</td>
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<tr>
<td>7.1.8.G</td>
<td>Suitable to support the intended use.</td>
<td>✓</td>
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<tr>
<td>7.1.9</td>
<td>MOTION BLUR <em>(Light valve systems only)</em></td>
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<tr>
<td>7.1.9.S</td>
<td>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.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7.1.9.R</td>
<td>Suitable to support the intended use.</td>
<td>✓</td>
<td></td>
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<tr>
<td>7.1.9.G</td>
<td>Suitable to support the intended use.</td>
<td>✓</td>
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<tr>
<td>7.1.10</td>
<td>SPECKLE TEST <em>(Laser systems only)</em></td>
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<tr>
<td>7.1.10.S</td>
<td>A test is required to determine that the speckle typical of laser-based displays is below a distracting level.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>7.1.10.R</td>
<td>Suitable to support the intended use.</td>
<td>✓</td>
<td></td>
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<tr>
<td>7.1.10.G</td>
<td>Suitable to support the intended use.</td>
<td>✓</td>
<td></td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
<td>VISUAL CUES</td>
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<td><strong>7.2</strong> ADDITIONAL DISPLAY SYSTEMS</td>
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<tr>
<td><strong>7.2.1</strong> HEAD-UP DISPLAY (where fitted)</td>
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<tr>
<td><strong>7.2.1.S</strong> The system should be shown to perform its intended function for each operation and phase of flight. An active display (repeater) of all parameters displayed on the pilot's combiner 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 combiner.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>7.2.1.R</strong> The system should be shown to perform its intended function for each operation and phase of flight. An active display (repeater) of all parameters displayed on the pilot's combiner 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 combiner.</td>
<td>✓</td>
<td></td>
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<tr>
<td><strong>7.2.1.G</strong> N/A.</td>
<td></td>
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<tr>
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<tr>
<td>7.2.2</td>
<td>ENHANCED FLIGHT VISION SYSTEM (EFVS) (Where fitted)</td>
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<tr>
<td>7.2.2.S</td>
<td>The EFVS simulator hardware/software, including associated cockpit displays and annunciation, should function the same or equivalent to the EFVS system installed in the aeroplane.</td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td></td>
<td>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 aeroplane type).</td>
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<tr>
<td></td>
<td>Image should be repeated on the IOS as for HUD requirement in 7.2.1.S herein.</td>
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<tr>
<td></td>
<td>IOS weather presets should be provided for EFVS minimums.</td>
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<tr>
<td>7.2.2.R</td>
<td>The EFVS simulator hardware/software, including associated cockpit displays and annunciation, should function the same or equivalent to the EFVS system installed in the aeroplane.</td>
<td></td>
<td>✓</td>
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<td></td>
<td>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 aeroplane type).</td>
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<td>7.3 VISUAL GROUND SEGMENT</td>
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<tr>
<td>7.3.S A test is required to demonstrate that the visibility is correct on final approach in CAT II conditions and the positioning of the aeroplane is correct relative to the runway.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>See Appendix B – Test 4.d.</td>
</tr>
<tr>
<td>7.3.R A test is required to demonstrate that the visibility is correct on final approach in CAT II conditions and the positioning of the aeroplane is correct relative to the runway.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>See Appendix B – Test 4.d.</td>
</tr>
<tr>
<td>7.3.G A demonstration of suitable visibility.</td>
<td>✓</td>
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## 8. REQUIREMENT — MOTION CUES

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<tbody>
<tr>
<td>8.R</td>
<td>Pilot receives an effective and representative motion cue and stimulus, which provides the appropriate sensations of acceleration of the aeroplane’s 6 degrees of freedom. Motion cues should always provide a correct sensation, for the approved use.</td>
<td></td>
<td></td>
<td>✓</td>
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</tr>
<tr>
<td>8.R.1</td>
<td>Pilot receives an effective and representative motion cue and stimulus, which provides the appropriate sensations of acceleration of the aeroplane’s 6 degrees of freedom. Motion cues should always provide a correct sensation, to support the approved use. These sensations may be generated by a variety of methods which are specifically not prescribed. The sensation of motion can be less for simplified non-type specific training, the magnitude of the cues being reduced.</td>
<td></td>
<td></td>
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<tr>
<td>8.G</td>
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### FEATURE TECHNICAL REQUIREMENT

#### MOTION CUES

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<tr>
<td><strong>8.1</strong></td>
<td>MOTION CUES GENERAL</td>
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<tr>
<td><strong>8.1.R</strong></td>
<td>Motion cues (force) in 6 DOF, as perceived by the pilot, should be representative of the simulated aeroplane’s motion (e.g. touchdown cues should be a function of the rate of descent (R/D) of the simulated aeroplane).</td>
<td></td>
<td>✓</td>
<td></td>
<td>SOC required.</td>
</tr>
<tr>
<td><strong>8.1.R1</strong></td>
<td>Motion cues (force) in 6 DOF, as perceived by the pilot, should be representative of the simulated aeroplane’s motion (e.g. touchdown cues should be a function of the R/D of the simulated aeroplane).</td>
<td>✓</td>
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<td>SOC required.</td>
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<td><strong>8.2</strong></td>
<td>MOTION FORCE CUEING</td>
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<tr>
<td><strong>8.2.R</strong></td>
<td>A motion system (force cueing) should produce cues at least equivalent to those of a 6 DOF platform motion system (i.e., pitch, roll, yaw, heave, sway, and surge).</td>
<td>✓</td>
<td></td>
<td></td>
<td>SOC required.</td>
</tr>
<tr>
<td><strong>8.2.R1</strong></td>
<td>A motion system (force cueing) should produce cues at least equivalent to those of a 6 DOF platform motion system (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.</td>
<td>✓</td>
<td></td>
<td></td>
<td>SOC required.</td>
</tr>
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<td>FEATURE TECHNICAL REQUIREMENT</td>
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<td>MOTION CUES</td>
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<tr>
<td>8.3  MOTION EFFECTS</td>
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<tr>
<td>8.3.R Motion effects should include characteristic motion vibrations, buffets and bumps that result from operation of the aeroplane, in so far as these mark an event or aeroplane state that can be sensed at the cockpit/flight deck. Such effects should be in at least 3 axes, x, y and z, to represent the effects as experienced in the aeroplane:</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>See Appendix C.</td>
</tr>
<tr>
<td>8.3.R (1) Taxiing effects such as lateral and directional cues resulting from steering and braking inputs.</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>8.3.R (2) Effects of runway and taxiway rumble, oleo deflections, uneven runway, runway contamination with associated anti-skid characteristics, centre line lights characteristics (such effects should be a function of groundspeed).</td>
<td>✓</td>
<td></td>
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<tr>
<td>8.3.R (3) Buffets on the ground due to spoiler/speedbrake extension and thrust reversal.</td>
<td>✓</td>
<td></td>
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<tr>
<td>8.3.R (4) Bumps associated with the landing gear.</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>8.3.R (5) Buffet during extension and retraction of landing gear.</td>
<td>✓</td>
<td></td>
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<tr>
<td>8.3.R (6) Buffet in the air due to flap and spoiler/speedbrake extension.</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>8.3.R (7) Buffet due to atmospheric disturbances, e.g. turbulence in three linear axes (isotropic).</td>
<td>✓</td>
<td></td>
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<tr>
<td>8.3.R (8) Approach to stall buffet.</td>
<td>✓</td>
<td></td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT MOTION CUES</td>
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<tr>
<td>8.3.R (9) Touchdown cues for main and nose gear.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>Touchdown bumps should reflect the effects of lateral and directional cues resulting from crab or crosswind landings.</td>
</tr>
<tr>
<td>8.3.R (10) Nosewheel scuffing (if applicable).</td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>8.3.R (11) Thrust effect with brakes set.</td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>8.3.R (12) Mach and manoeuvre buffet.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>8.3.R (13) Tire failure dynamics.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>8.3.R (14) Engine failures, malfunctions and engine damage.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>Appropriate cues to aid recognition of failures for flight critical cases (e.g. directional and lateral cues for asymmetric engine failure).</td>
</tr>
<tr>
<td>8.3.R (15) Tail and pod strike.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>8.3.R (16) Other significant vibrations, buffets and bumps that are not mentioned above (e.g. RAT), or checklist items such as motion effects due to pre-flight flight control inputs.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>8.3.R1 Motion effects should include characteristic motion vibrations, buffets and bumps that result from operation of the aeroplane, in so far as these mark an event or aeroplane state that can be sensed at the cockpit/flight deck. Such effects should be in at least 3 axes, x, y and z, to represent the effects as experienced in the aeroplane:</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>See Appendix C.</td>
</tr>
<tr>
<td>8.3.R1 (1) Taxiing effects such as lateral and directional cues resulting from steering and braking inputs.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>8.3.R1 (2) Effects of runway and taxiway rumble, oleo deflections, uneven runway, runway contamination with associated anti-skid characteristics, centre line lights characteristics (such effects should be a function of groundspeed).</td>
<td></td>
<td></td>
<td>✓</td>
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<td>FEATURE TECHNICAL REQUIREMENT</td>
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<tr>
<td>8.3.R1</td>
<td>(3) Buffets on the ground due to spoiler/speedbrake extension and thrust reversal.</td>
<td>✓</td>
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<tr>
<td>8.3.R1</td>
<td>(4) Bumps associated with the landing gear.</td>
<td>✓</td>
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<tr>
<td>8.3.R1</td>
<td>(5) Buffet during extension and retraction of landing gear.</td>
<td>✓</td>
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<tr>
<td>8.3.R1</td>
<td>(6) Buffet in the air due to flap and spoiler/speedbrake extension.</td>
<td>✓</td>
<td></td>
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<tr>
<td>8.3.R1</td>
<td>(7) Buffet due to atmospheric disturbances, e.g. turbulence in three linear axes (isotropic).</td>
<td>✓</td>
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<tr>
<td>8.3.R1</td>
<td>(8) Approach to stall buffet.</td>
<td>✓</td>
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<tr>
<td>8.3.R1</td>
<td>(9) Touchdown cues for main and nose gear.</td>
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<tr>
<td>8.3.R1</td>
<td>(10) Nosewheel scuffing (if applicable).</td>
<td>✓</td>
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<td>8.3.R1</td>
<td>(11) Thrust effect with brakes set.</td>
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<td>8.3.R1</td>
<td>(12) Mach and manoeuvre buffet.</td>
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<td>8.3.R1</td>
<td>(13) Tire failure dynamics.</td>
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<tr>
<td>8.3.R1</td>
<td>(14) Engine failures, malfunctions and engine damage.</td>
<td>✓</td>
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<tr>
<td>8.3.R1</td>
<td>(15) Tail and pod strike.</td>
<td>✓</td>
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<tr>
<td>8.3.R1</td>
<td>(16) Other significant vibrations, buffets and bumps that are not mentioned above (e.g. RAT), or checklist items such as motion effects due to pre-flight flight control inputs.</td>
<td>✓</td>
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Touchdown bumps should reflect the effects of lateral and directional cues resulting from crab or crosswind landings.

Appropriate cues to aid recognition of failures for flight critical cases (e.g. directional and lateral cues for asymmetric engine failure).
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<td>8.4 MOTION VIBRATIONS</td>
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<tr>
<td>8.4.R Motion vibrations tests are required and should include recorded results that allow the comparison of relative amplitudes versus frequency (relevant frequencies up to at least 20 Hz). Characteristic motion vibrations that result from operation of the aeroplane should be present, in so far as vibration marks an event or aeroplane state that can be sensed at the cockpit/flight deck. The FSTD should be programmed and instrumented in such a manner that the characteristic vibration modes can be measured and compared to aeroplane data.</td>
<td>✓</td>
<td></td>
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<td></td>
<td>See Appendix B – Test 3.f. An SOC is required.</td>
</tr>
<tr>
<td>8.4.R (1) Thrust effects with brakes set.</td>
<td>✓</td>
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<td>8.4.R (2) Landing gear extended buffet.</td>
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<td>8.4.R (3) Flaps extended buffet.</td>
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<td>8.4.R (4) Speedbrake deployed buffet.</td>
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<td>8.4.R (5) Approach to stall buffet.</td>
<td>✓</td>
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<td>8.4.R (6) High speed or Mach buffet.</td>
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<td>8.4.R (7) In-flight vibrations.</td>
<td>✓</td>
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<td>Propeller-driven aeroplanes only.</td>
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<td>MOTION CUES</td>
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<td>8.4.R1</td>
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<tr>
<td>Motion vibrations tests are required and should include recorded results that allow the comparison of relative amplitudes versus frequency (relevant frequencies up to at least 20 Hz). Characteristic motion vibrations that result from operation of the aeroplane should be present, in so far as the vibration marks an event or aeroplane state that can be sensed at the cockpit/flight deck. The FSTD should be programmed and instrumented in such a manner that the characteristic vibration modes can be measured.</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>8.4.R1 (1) Thrust effects with brakes set.</td>
<td>✓</td>
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<tr>
<td>8.4.R1 (2) Landing gear extended buffet.</td>
<td>✓</td>
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<tr>
<td>8.4.R1 (3) Flaps extended buffet.</td>
<td>✓</td>
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<tr>
<td>8.4.R1 (4) Speedbrake deployed buffet.</td>
<td>✓</td>
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<tr>
<td>8.4.R1 (5) Approach to stall buffet.</td>
<td>✓</td>
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</tr>
<tr>
<td>8.4.R1 (6) High speed or Mach buffet.</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>8.4.R1 (7) In-flight vibrations.</td>
<td>✓</td>
<td>Propeller-driven aeroplanes only.</td>
<td>See Appendix B – Test 3.f. An SOC is required.</td>
<td></td>
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<td>FEATURE GENERAL REQUIREMENT</td>
<td>ENVIRONMENT - ATC</td>
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<tr>
<td>9.S</td>
<td>Automated dynamic environment in the terminal area, including ATC responses to ownship voice transmissions and appropriate ATC initiated transmissions for the approved use. Content and intensity of ownship and othership messages specific to airport context and frequency, in English (as per ICAO Doc 4444, PANS-ATM - Air Traffic Management). Randomised messages to ownship and othership messages specific to airport. Correlation with visual ground, landing and departing traffic, including terminal area simulation of airports appropriate to the training programme.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>9.R</td>
<td>Flight phase and content specific ATC messages in the terminal area, including appropriate responses to ownship voice transmissions to support the approved use. Content and intensity of ownship and othership messages in English (as per ICAO Doc 4444, PANS ATM - Air Traffic Management). Randomised messages to ownship and background messages representative of ATC control.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>FEATURE GENERAL REQUIREMENT ENVIRONMENT - ATC</td>
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</tr>
<tr>
<td>9.G</td>
<td>Flight phase and content specific ATC messages, including responses to ownship voice transmissions in appropriate flight phases, to support the approved use. Content of ownship messages in English (as per ICAO Doc 4444, PANS ATM — Air Traffic Management). Messages to ownship typical of ATC control. Can be achieved by the instructor providing the ATC simulation.</td>
<td>✓</td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT ENVIRONMENT - ATC</td>
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<td>COMMENTS</td>
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<tr>
<td>AUTOMATED WEATHER REPORTING</td>
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<tr>
<td>Automated weather reporting.</td>
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<td>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 with part-time or no towers should be considered where relevant to the operation.</td>
</tr>
<tr>
<td>9.1.S Multiple station automated weather reporting.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>The system should have the capability of generating different automated weather reporting messages providing weather conditions and different other predefined conditions at all airports in range allowing flight crews to simultaneously listen in to concurrent automated weather reporting messages from different airports. The instructor should have the ability to override each single value and each predefined message from the instructor station.</td>
</tr>
<tr>
<td>9.1.R Single station automated weather reporting.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>At least one automated weather reporting message is required for all airports in range. The message(s) should consist of the actual weather conditions set in the FSTD including reference airport, 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.</td>
</tr>
<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
<td>ENVIRONMENT - ATC</td>
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<tr>
<td>9.1.G</td>
<td>Single station automated weather reporting.</td>
<td>✓</td>
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<td>9.2</td>
<td>BACKGROUND CHATTER</td>
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<tr>
<td>9.2.1 S,R,G</td>
<td>Background chatter (party line).</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td></td>
<td>In general all background chatter should meet the following criteria:</td>
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<td></td>
<td>1. communications should make sense within the context of the simulation environment and should not contain obviously erroneous information;</td>
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<td></td>
<td>2. only messages relevant to the purpose of a given frequency should be heard on said frequency;</td>
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<td></td>
<td>3. simulated communications on a given frequency should not step over one another or over communications from the simulator crew; and</td>
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<td>4. reasonable pauses should be provided between communication exchanges to allow the simulator crew access to the frequency when required.</td>
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<td>FEATURE TECHNICAL REQUIREMENT ENVIRONMENT - ATC</td>
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<tr>
<td>9.2.2 S Content-defined – Location-specific and content-specific messages fully correlated to the visually simulated traffic.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>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 3 specific terminal areas. The 3 specific terminal areas should be part of the approved training programme.</td>
</tr>
<tr>
<td>9.2.2 R Context-defined – Generic messages common to all airports correlated to visually simulated traffic.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>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 3 specific terminal areas. The 3 specific terminal areas should be part of the approved training programme.</td>
</tr>
<tr>
<td>FEATURE TECHNICAL REQUIREMENT ENVIRONMENT - ATC</td>
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<tr>
<td>9.2.2 G Context Generic – Generic messages with no correlation.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>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.</td>
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<tr>
<td>9.3 ATC SIMULATION - INTERACTION WITH SIMULATOR</td>
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<td>Messages received related to own ship position, operational situation and environmental conditions reflecting visual settings and TCAS scenario if applicable.</td>
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</table>
### FEATURE TECHNICAL REQUIREMENT

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<thead>
<tr>
<th>ENVIRONMENT - ATC</th>
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<th>COMMENTS</th>
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<tbody>
<tr>
<td>9.3.S,R</td>
<td></td>
<td></td>
<td>✓</td>
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</table>

**Simulation Parameters**

The ATC communication simulation system together with aeroplane systems and applicable environment simulation (including visual, when applicable) for at least 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;
9. Active runways;
10. Runway condition: contamination and depth of contamination;
11. Braking action;
12. UTC;
13. Position, track, heading and height of own aeroplane; and
14. Subject aeroplane call sign.

The system should include a minimum of 3 specific terminal areas. The 3 specific terminal areas should be part of the approved training programme. Including visual, when applicable.
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<tr>
<th>FEATURE TECHNICAL REQUIREMENT</th>
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<th>COMMENTS</th>
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<tr>
<td>9.4</td>
<td>ATC SIMULATION - INTERACTION WITH INSTRUCTOR</td>
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<td>9.4.S,R</td>
<td>The instructor should be able to interact with the scenario by injecting messages to the own ship aeroplane. When applicable, these messages should be grouped by phase of flight or category as follows:</td>
<td>✓</td>
<td>✓</td>
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<td>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 crews under training, testing or checking.</td>
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<td>1. Gate:</td>
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<td>a. Dispatch;</td>
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<td>b. Maintenance;</td>
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<td></td>
<td>c. Departure ATIS;</td>
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<td></td>
<td>d. Route clearance;</td>
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<td>e. Pushback; and</td>
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<td></td>
<td>f. Other routine ATC/company communication;</td>
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<td></td>
<td>2. De-icing;</td>
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<td>3. Taxi;</td>
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<td>4. Hold;</td>
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<td>5. Take-off;</td>
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<td>6. After take-off;</td>
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<td>7. Climb;</td>
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<td>8. En-route;</td>
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<td>9. Descent;</td>
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<td>10. Arrival ATIS;</td>
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<td>11. Hold;</td>
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<td>12. Approach;</td>
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<td>13. Landing;</td>
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<td>14. Emergency;</td>
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<td>15. Other communication; and</td>
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<td>FEATURE TECHNICAL REQUIREMENT</td>
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<tr>
<td>9.5 ATC MESSAGE TRIGGERING</td>
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<td></td>
<td>The instructor should be able to trigger messages manually or automatically.</td>
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<tr>
<td>9.5.1 Manual (basic).</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>The message is triggered at the instructor’s request by an instructor’s action from the IOS.</td>
</tr>
<tr>
<td>9.5.2 Automatic (enhanced).</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>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).</td>
</tr>
<tr>
<td>9.5.3 The ATC communication simulation system should give the instructor the ability to pause and/or disable it and return to the classic no-ATC simulation.</td>
<td></td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>9.6 PHRASEOLOGY</td>
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<tr>
<td>9.6.1 Phraseology and voice characteristics.</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>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% realism to achieve proper situational awareness among the students during training sessions.</td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT ENVIRONMENT - ATC</td>
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<tr>
<td><strong>9.7</strong> FLIGHT PHASE SPECIFIC ATC FREQUENCY RECOGNITION</td>
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<tr>
<td>9.7.1 Communications should be appropriate to the radio frequencies set in the cockpit:</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Flight phase specific ATC frequency recognition, a requirement for all levels of ATC simulation, means that all communication received by the pilot should be appropriate to the radio frequencies set in the cockpit.</td>
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</tr>
<tr>
<td>1) single-frequency communications;</td>
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<tr>
<td>2) multiple-frequency communications.</td>
<td>✓</td>
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<td></td>
<td>Example: The pilot listening to ATIS on VHF 1 while the copilot waits for clearance delivery on VHF 2.</td>
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</tr>
<tr>
<td>9.7.2 The simulated environment should be kept updated in conjunction with other system updates with regard to company or ATC radio frequency changes.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>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.</td>
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<tr>
<td><strong>9.8</strong> INSTRUCTOR CONTROL OVER OTHER TRAFFIC</td>
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<tr>
<td>9.8.1 Instructor control over other traffic.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Examples of instructor control of other traffic:</td>
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<tr>
<td>Instructor should have the ability to control other traffic.</td>
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<td>• Priority for ownership for take–off, landing and ground manoeuvres with respect to other traffic;</td>
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</tr>
<tr>
<td>9.8.2 Correlation. Communications should be consistent with other ground and air traffic representations in the simulation and aeroplane systems (TCAS).</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>• Another aeroplane in the scenario to have an emergency or to obstruct ownership aeroplane;</td>
<td></td>
</tr>
<tr>
<td>Correlation. Communications should be consistent with other ground and air traffic representations in the simulation and aeroplane systems (TCAS).</td>
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<td>• Levels of traffic activity in the scenario; and</td>
<td></td>
</tr>
<tr>
<td>Correlation. Communications should be consistent with other ground and air traffic representations in the simulation and aeroplane systems (TCAS).</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>• Restrictions on speed for an approaching aeroplane.</td>
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<tr>
<td>Air traffic control communications should be consistent with other dynamic ground and air traffic movements, including those influenced by traffic conflicts and subject aeroplane priority issues.</td>
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<td>Traffic information displayed by both visual and onboard systems should be consistent with TCAS.</td>
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### FEATURE TECHNICAL REQUIREMENT

**ENVIRONMENT - ATC** | **G** | **R1** | **R** | **S** | COMMENTS
--- | --- | --- | --- | --- | ---
9.8.3 S,R | Traffic flow.  
Unless otherwise selected by the instructor, airport traffic flow should be representative of flow density for the time of day at the modelled airport.  
Representative traffic separation times should be respected. | | ✓ | ✓ | Examples of appropriate traffic flows for a major airport:  
Light: 1 to 15 take-offs and/or landings per hour or less than 20 total airport movements per hour.  
Medium: 16 to 50 take-offs and/or landings per hour or 70 total movements per hour.  
Heavy: 51 or more take-offs and/or landings per hour or greater than 100 total movements per hour.

### 9.9 DATALINK COMMUNICATIONS

9.9.1.S ACARS/ATN | ✓ | If installed.
9.9.2.S FANS | ✓ | If installed.
9.9.3.S OTHER | ✓ | If installed.
## 10. REQUIREMENT — ENVIRONMENT — NAVIGATION

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<tr>
<th></th>
<th>FEATURE GENERAL REQUIREMENT ENVIRONMENT - NAVIGATION</th>
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<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>10.S</td>
<td>Navigational data with the corresponding approach facilities to support the approved use. Navigation aids should be usable within range or line-of-sight without restriction, as applicable to the geographic area.</td>
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<td>✓</td>
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<tr>
<td>10.R</td>
<td>N/A.</td>
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<tr>
<td>10.G</td>
<td>N/A.</td>
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<td>ENVIRONMENT - NAVIGATION</td>
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<tr>
<td>10.1 NAVIGATION DATABASE</td>
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<tr>
<td>10.1.S Navigation data base sufficient to support simulated aeroplane systems for real world operations.</td>
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<td></td>
<td>✓</td>
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<tr>
<td>10.1.R N/A.</td>
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<tr>
<td>10.1.G N/A.</td>
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<td>10.2 MINIMUM AIRPORT REQUIREMENT</td>
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<tr>
<td>10.2.S Complete navigation database for at least 3 airports with corresponding precision and non-precision approach procedures, including regular updates.</td>
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<td>✓</td>
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<tr>
<td>10.2.R N/A.</td>
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<tr>
<td>10.2.G N/A.</td>
<td></td>
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<tr>
<td>10.3 INSTRUCTOR CONTROLS</td>
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</tr>
<tr>
<td>10.3.S Instructor controls of internal and external navigational aids.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>10.3.R N/A.</td>
<td></td>
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<tr>
<td>10.3.G N/A.</td>
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<tr>
<td>10.4 ARRIVAL/DEPARTURE FEATURES</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>10.4.S Navigational data with all the corresponding standard arrival and departure procedures.</td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>10.4.R N/A.</td>
<td></td>
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<tr>
<td>10.4.G N/A.</td>
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<td>FEATURE TECHNICAL REQUIREMENT</td>
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<td>ENVIRONMENT - NAVIGATION</td>
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<tr>
<td>10.5 NAVIGATION AIDS RANGE</td>
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<tr>
<td>10.5.S Navigation aids should be usable within range or line-of-sight without restriction, as applicable to the geographic area.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>Replication of the geographic environment with its specific limitations.</td>
<td></td>
</tr>
<tr>
<td>10.5.R N/A.</td>
<td></td>
<td></td>
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<tr>
<td>10.5.G N/A.</td>
<td></td>
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</table>
### 11. REQUIREMENT — ENVIRONMENT — ATMOSPHERE AND WEATHER

<table>
<thead>
<tr>
<th>11.S</th>
<th>N/A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.R</td>
<td>Fully integrated dynamic environment simulation including a representative atmosphere with weather effects to support the approved use. The environment should be synchronised with appropriate aeroplane and simulation features to provide integrity. Environment simulation should include thunderstorms, wind shear, turbulence, microbursts and appropriate types of precipitation.</td>
</tr>
<tr>
<td>11.G</td>
<td>Basic atmospheric model, pressure, temperature, visibility, cloud base and winds to support the approved use. The environment should be synchronised with appropriate aeroplane and simulation features to provide integrity.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FEATURE GENERAL REQUIREMENT ENVIRONMENT — ATMOSPHERE AND WEATHER</th>
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<th>R1</th>
<th>R</th>
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<th>COMMENTS</th>
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<tr>
<td>11.R</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>11.G</td>
<td>✓</td>
<td></td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
<td>ENVIRONMENT – ATMOSPHERE AND WEATHER</td>
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<tr>
<td>11.1 STANDARD ATMOSPHERE</td>
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<td>11.1.S</td>
<td>N/A.</td>
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</tr>
<tr>
<td>11.1.R, G</td>
<td>Simulation of the standard atmosphere including instructor control over key parameters.</td>
<td>✓</td>
<td></td>
<td>✓</td>
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<tr>
<td>11.2 WIND SHEAR</td>
<td></td>
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<td>11.2.S</td>
<td>N/A.</td>
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</tbody>
</table>
| 11.2.R                         | The FSTD should employ wind shear models that provide training for recognition and necessary corrective pilot actions for the following critical phases of flight:  
(1) prior to take-off rotation;  
(2) at lift-off;  
(3) during initial climb; and  
(4) on final approach, below 150 m (500 ft) AGL. | ✓ |     | ✓|   |          |
<p>| 11.2.G                         | The FSTD should employ wind shear models that provide training for recognition of wind shear phenomena. | ✓ |     |   |   |          |
|                               | Refer to Appendix B – Test 2.g.       |   |     |   |   |          |
|                               | The QTG should reference the FAA Wind Shear Training Aid or present alternate aeroplane-related data, including the implementation method(s) used. If the alternate method is selected, wind models from the Royal Aeroplane Establishment (RAE) Wind Shear Training, the Joint Airport Weather Studies (JAWS) Project and other recognized sources may be implemented, but should be supported and properly referenced in the QTG. |   |     |   |   |          |
|                               | A subjective test is required. See Appendix C. |   |     |   |   |          |</p>
<table>
<thead>
<tr>
<th>FEATURE TECHNICAL REQUIREMENT</th>
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<th>S</th>
<th>COMMENTS</th>
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<tr>
<td>11.3.S WEATHER EFFECTS</td>
<td></td>
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<tr>
<td>11.3.R The following weather effects as observed on the visual system should be simulated and respective instructor controls provided.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>A subjective test is required. See Appendix C.</td>
</tr>
<tr>
<td>11.3.G The following weather effects as observed on the visual system should be simulated and respective instructor controls provided.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>A subjective test is required. See Appendix C of this Part.</td>
</tr>
<tr>
<td>(1) Multiple cloud layers with adjustable bases, tops, sky coverage and scud effect.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Not required for IR and MPL2 (T).</td>
</tr>
<tr>
<td>(2) Storm cells activation and/or deactivation.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Not required for IR and MPL2 (T).</td>
</tr>
<tr>
<td>(3) Visibility and runway visual range (RVR), including fog and patchy fog effect.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Objective test required. Refer to Appendix B – Test 4.d. Not required for IR and MPL2 (T).</td>
</tr>
<tr>
<td>(4) Effects on ownship external lighting.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Not required for IR and MPL2 (T).</td>
</tr>
<tr>
<td>(5) Effects on airport lighting (including variable intensity and fog effects).</td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>(6) Surface contaminants (including wind blowing effect).</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Not required for IR and MPL2 (T).</td>
</tr>
<tr>
<td>(7) Variable precipitation effects (rain, hail, snow).</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Not required for IR and MPL2 (T).</td>
</tr>
<tr>
<td>(8) In-cloud airspeed effect.</td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>(9) Gradual visibility changes entering and breaking out of cloud.</td>
<td></td>
<td>✓</td>
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### FEATURE TECHNICAL REQUIREMENT

#### ENVIRONMENT – ATMOSPHERE AND WEATHER

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<tr>
<td>11.4</td>
<td>INSTRUCTOR CONTROLS</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
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<td>11.4.S</td>
<td>N/A.</td>
<td></td>
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<tr>
<td>11.4.R, G</td>
<td>The following features should be simulated with appropriate instructor controls provided:</td>
<td></td>
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<tr>
<td></td>
<td>(1) surface wind speed, direction and gusts;</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td></td>
<td>(2) intermediate and high altitude wind speed and direction;</td>
<td>✓</td>
<td></td>
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<tr>
<td></td>
<td>(3) thunderstorms and microbursts; and</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td></td>
<td>(4) turbulence.</td>
<td>✓</td>
<td>✓</td>
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### 12. REQUIREMENT — ENVIRONMENT — AIRPORTS AND TERRAIN

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<tr>
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<tr>
<td>12.S</td>
<td>N/A.</td>
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<tr>
<td>12.R</td>
<td>Specific airport models with topographical features to support the approved use. Correct terrain modelling, runway orientation, markings, lighting, dimensions and taxiways. Visual terrain and EGPWS databases shall be matched to support training to avoid CFIT accidents. Where the device is required to perform low visibility operations, 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 and runway lighting.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>Note.— The following requirements should be read in conjunction with Appendix C, paragraph 12 to fully understand the details to be provided.</td>
<td></td>
</tr>
<tr>
<td>12.R, (S)</td>
<td>Specific airport model/s with topographical features to support the approved use. Correct terrain modelling, runway orientation, markings, lighting, dimensions and taxiways. Visual terrain and EGPWS databases should be matched to support training to avoid CFIT accidents. For specific VFR cross-country training the capability to replicate ground visual references and topographical features sufficient to support VFR navigation according to appropriate charts - minimum standard 1:500 000 scale mapping.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>PPL application only.</td>
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<tr>
<td></td>
<td>FEATURE GENERAL REQUIREMENT</td>
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<td>12</td>
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<tr>
<td>12.G</td>
<td>Generic airport models with topographical features to support the approved use. Correct terrain modelling, runway orientation, markings, lighting, dimensions and taxiways.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Note.— The requirements should be read in conjunction with Appendix C, paragraph 12 to fully understand the details to be provided.</td>
<td></td>
</tr>
<tr>
<td>12.G (S)</td>
<td>Generic airport models with topographical features to support the approved use. Correct terrain modelling, runway orientation, markings, lighting, dimensions and taxiways. For specific VFR cross-country training the capability to replicate ground visual references and topographical features sufficient to support VFR navigation according to appropriate charts - minimum standard 1:500 000 scale mapping.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>CPL application only.</td>
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</table>
### FEATURE TECHNICAL REQUIREMENT

**ENVIRONMENT - AIRPORTS AND TERRAIN**

<table>
<thead>
<tr>
<th>12.1</th>
<th>VISUAL CUES</th>
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</thead>
</table>
| 12.1.1R | Visual cues to assess sink rate and depth perception during take-off and landing should be provided. This should include:  
   (1) surface on runways, taxiways, and ramps;  
   (2) terrain features; and  
   (3) highly detailed and accurate surface depiction of the terrain surface within an area sufficient to achieve cross-country flying under VFR conditions. | ✓ | ✓ | ✓ | PPL and CPL application only. |

| 12.1.1R | Visual cues to assess sink rate and depth perception during take-off and landing should be provided. This should include:  
   (1) surface on runways, taxiways, and ramps;  
   (2) terrain features; and  
   (3) highly detailed and accurate surface depiction of the terrain surface within an approximate area from 400 m (1/4 sm) before the runway approach end to 400 m (1/4 sm) beyond the runway departure end with a total width of approximately 400 m (1/4 sm) including the width of the runway. | ✓ | |
<table>
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<tr>
<th>FEATURE TECHNICAL REQUIREMENT</th>
<th>ENVIRONMENT - AIRPORTS AND TERRAIN</th>
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<th>R</th>
<th>S</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>12.1.1G</td>
<td>Visual cues to assess sink rate and depth perception during take-off and landing should be provided. This should include: (1) surface on runways, taxiways, and ramps; and (2) terrain features.</td>
<td>✓</td>
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<tr>
<td>12.2 VISUAL EFFECTS</td>
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<tr>
<td>12.2.1R</td>
<td>The system should provide visual effects for: (1) light poles; (2) raised edge lights as appropriate; and (3) glow associated with approach lights in low visibility before physical lights are seen.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>Note.— For PPL (T), “(3) glow associated with approach lights in low visibility before physical lights are seen”, is not required.</td>
</tr>
<tr>
<td>12.3 ENVIRONMENT ATTITUDE</td>
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<tr>
<td>12.3.1 S,R,G</td>
<td>The simulator should provide for accurate portrayal of the visual environment relating to the simulator attitude.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Visual attitude versus FSTD attitude is a comparison of pitch and roll of the horizon as displayed in the visual scene compared to the display on the attitude indicator. Required for initial qualification only (SOC acceptable).</td>
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<tr>
<td>12.4 AIRPORT SCENES</td>
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<tr>
<td>12.4.1.a R</td>
<td>The system should include at least 3 designated real-world airports available in daylight, twilight (dusk or dawn) and night illumination states.</td>
<td>✓</td>
<td></td>
<td></td>
<td>The designated real-world airports should be part of the approved training programme. Applicable to R with exception of PPL (T).</td>
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<td>FEATURE TECHNICAL REQUIREMENT</td>
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<td><strong>ENVIRONMENT - AIRPORTS AND TERRAIN</strong></td>
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<tr>
<td>12.4.1.b R</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>The system should include at least 1 designated real-world airport available in daylight, twilight (dusk or dawn) and night illumination states. The designated real-world airport(s) should be part of the approved training programme. Applicable to PPL (T) only.</td>
<td></td>
</tr>
<tr>
<td>12.4.1 G</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>The system should include a generic airport available in daylight, twilight (dusk or dawn) and night illumination states.</td>
<td></td>
</tr>
<tr>
<td>12.4.2.1 S,R,G</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Daylight capability. SOC required for system capability. System objective tests are required. See Appendix B – Test 4.a. Scene content tests are also required. See Appendix C.</td>
<td></td>
</tr>
<tr>
<td>12.4.2.2 S,R,G</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>The system should provide full-colour presentations and sufficient surfaces with appropriate textural cues to successfully accomplish a visual approach, landing and airport movement (taxi).</td>
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</tr>
<tr>
<td>12.4.2.3 R</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>Surface shading effects should be consistent with simulated sun position. This does not imply continuous time of day.</td>
<td></td>
</tr>
<tr>
<td>12.4.2.4 R</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>Total scene content comparable in detail to that produced by 10 000 visible textured surfaces and 6 000 visible lights should be provided.</td>
<td></td>
</tr>
<tr>
<td>12.4.2.4 G</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Total scene content should be sufficient to identify the airport and represent the surrounding terrain.</td>
<td></td>
</tr>
<tr>
<td>12.4.2.5 R</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>The system should have sufficient capacity to display 16 simultaneously moving objects.</td>
<td></td>
</tr>
<tr>
<td>12.4.3.1 S,R</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Twilight (dusk) capability.</td>
<td></td>
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<tr>
<td>FEATURE TECHNICAL REQUIREMENT</td>
<td>ENVIRONMENT - AIRPORTS AND TERRAIN</td>
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<tr>
<td>12.4.3.2 S,R</td>
<td>The system should provide twilight (or dusk) visual scenes with full colour presentations of reduced ambient intensity and typical terrain characteristics such as fields, roads and bodies of water and surfaces illuminated by representative ownership lighting (e.g. landing lights) sufficient to successfully accomplish visual approach, landing and airport movement (taxi).</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>12.4.3.3 R</td>
<td>Total scene content comparable in detail to that produced by 10 000 visible textured surfaces and 15 000 visible lights should be provided.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>12.4.3.3 R</td>
<td>Scenes should include self-illuminated objects such as road networks, ramp lighting and airport signage, to conduct a visual approach, landing and airport movement (taxi).</td>
<td>✓</td>
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</tr>
<tr>
<td>12.4.3.4 S,R</td>
<td>The system should include a definable horizon.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>If provided, directional horizon lighting should have correct orientation and be consistent with surface shading effects.</td>
<td></td>
</tr>
<tr>
<td>12.4.3.6 R</td>
<td>The system should have sufficient capacity to display 16 simultaneously moving objects.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.4.4 S,R</td>
<td>Night capability.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.4.4.1 S,R</td>
<td>The system should provide at night all features applicable to the twilight scene, as defined above, with the addition of the need to portray reduced ambient intensity that removes ground cues that are not self-illuminating or illuminated by aeroplane lights (e.g. landing lights).</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEATURE</td>
<td>TECHNICAL REQUIREMENT</td>
<td>ENVIRONMENT - AIRPORTS AND TERRAIN</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
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</tr>
<tr>
<td>12.5</td>
<td>AIRPORT CLUTTER</td>
<td></td>
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</tr>
<tr>
<td>12.5.1R</td>
<td>Airport models should include clutter such as gates, aeroplanes, and ground handling equipment.</td>
<td>✓</td>
<td>Clutter need not be dynamic unless required (e.g. ATC correlation).</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>12.6</td>
<td>DATABASE CURRENCY</td>
<td></td>
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<tr>
<td>12.6.1R</td>
<td>The specific airports used in the system should be maintained current with the state of the corresponding real-world airports as identified in the airport charts.</td>
<td>✓</td>
<td>Applicable to devices supporting the following: TP: MPL4, TR, ATPL, RO, IO, CQ and RL; and T: Re.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>12.7</td>
<td>VISUAL SYSTEM FOR REDUCED FOV</td>
<td></td>
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</tr>
<tr>
<td>12.7.1G</td>
<td>The system should provide a visual scene with sufficient scene content to allow a pilot to successfully accomplish a visual landing. Scenes should include a definable horizon and typical terrain characteristics such as fields, roads and bodies of water and surfaces illuminated by aeroplane landing lights.</td>
<td>✓</td>
<td>Airport model may be generic (no specific topographical features required).</td>
<td></td>
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</tr>
<tr>
<td>FEATURE TECHNICAL REQUIREMENT ENVIRONMENT - AIRPORTS AND TERRAIN</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
<tr>
<td><strong>12.7.2G</strong> Total scene content comparable in detail to that produced by 3 500 visible textured surfaces and 5 000 visible lights should be provided.</td>
<td>✓</td>
<td></td>
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<tr>
<td><strong>12.8 VFR TRAINING</strong></td>
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</tr>
<tr>
<td><strong>12.8.1 S, G(S), R(S)</strong> The system, when used for VFR training, should include a database area that can support a 300 nautical miles triangular flight incorporating three airports. Within the defined area the system should replicate ground visual references and topographical features sufficient to support VFR navigation according to appropriate charts.</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>Applies only to support VFR operations when used for CPL and PPL training. Correlation should be with 1:500 000 scale VFR Navigation Charts at a minimum, or larger scales (e.g. 1:250 000) if applicable to the area.</td>
<td></td>
</tr>
<tr>
<td><strong>12.9 LOW VISIBILITY TRAINING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Applicable to devices supporting the following: TP: MPL4, TR, ATPL, RO, IO, CO, RL and MPL3; and T: Re and MPL3.</td>
<td></td>
</tr>
<tr>
<td><strong>12.9.1R</strong> The system should include 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 and runway lighting.</td>
<td></td>
<td>✓</td>
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</table>
### 13. REQUIREMENT — MISCELLANEOUS

<table>
<thead>
<tr>
<th></th>
<th>FEATURE GENERAL REQUIREMENT</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>13.S</td>
<td>N/A.</td>
<td></td>
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<tr>
<td>13.R</td>
<td>N/A.</td>
<td></td>
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</tr>
<tr>
<td>13.G</td>
<td>N/A.</td>
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<tr>
<td>13</td>
<td>FEATURE TECHNICAL REQUIREMENT MISCELLANEOUS</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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<tr>
<td>13.1</td>
<td>INSTRUCTOR OPERATING STATION</td>
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</tr>
<tr>
<td>13.1S</td>
<td>The instructor station should provide an adequate view of the pilots’ panels and forward windows.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>13.1R</td>
<td>The instructor station should provide an adequate view of the pilots’ panels and forward windows.</td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>13.1G</td>
<td>N/A.</td>
<td></td>
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<tr>
<td>13.2</td>
<td>INSTRUCTOR CONTROLS</td>
<td></td>
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<tr>
<td>13.2</td>
<td>Instructor controls should be provided for all required system variables, freezes, resets and for insertion of malfunctions to simulate abnormal or emergency conditions. The effects of these malfunctions should be sufficient to correctly exercise the procedures in relevant operating manuals.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>13.3</td>
<td>SELF–DIAGNOSTIC TESTING</td>
<td></td>
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<tr>
<td>13.3S</td>
<td>Self-diagnostic testing of 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.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>An SOC is required.</td>
</tr>
<tr>
<td>13.4</td>
<td>COMPUTER CAPACITY</td>
<td></td>
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<tr>
<td>13.4</td>
<td>Sufficient FSTD computer capacity, accuracy, resolution and dynamic response should be provided to fully support the overall FSTD fidelity needed to meet the qualification level sought.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>An SOC is required.</td>
</tr>
<tr>
<td>13</td>
<td>FEATURE TECHNICAL REQUIREMENT MISCELLANEOUS</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
<tr>
<td>13.5</td>
<td>AUTOMATIC TESTING FACILITIES</td>
<td></td>
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</tr>
<tr>
<td>13.5S</td>
<td>Automatic QTG/validation testing of FSTD hardware and software to determine compliance with the validation requirements should be available.</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>Evidence of testing should include test identification, FSTD number, date, time, conditions, tolerances, and the appropriate dependent variables portrayed in comparison with the aeroplane standard.</td>
</tr>
<tr>
<td>13.5 R,G</td>
<td>Validation testing of FSTD hardware and software to enable recurrent testing should be available.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>13.6</td>
<td>UPDATES TO FSTD HARDWARE AND SOFTWARE</td>
<td></td>
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</tr>
<tr>
<td>13.6 S,R</td>
<td>Timely permanent update of FSTD hardware and software should be conducted subsequent to aeroplane modification where it affects training, sufficient for the qualification level sought.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>13.6G</td>
<td>Timely permanent update of FSTD hardware and software should be conducted subsequent to FSTD manufacturer recommendation where it affects training and/or safety.</td>
<td>✓</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>13.7</td>
<td>DAILY PRE-FLIGHT DOCUMENTATION</td>
<td></td>
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</tr>
<tr>
<td>13.7 S,R,G</td>
<td>Daily pre-flight documentation either in the daily log or in a location easily accessible for review is required.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>FEATURE TECHNICAL REQUIREMENT</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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<tr>
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<td>MISCELLANEOUS</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>13.8</td>
<td>SYSTEM INTEGRATION</td>
<td></td>
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</tr>
<tr>
<td>13.8</td>
<td>System Integration.</td>
<td></td>
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</tbody>
</table>

Relative response of the visual system, cockpit/flight deck 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 100 milliseconds (ms). Motion onset should also occur within the system dynamic response limit of 100 ms. 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. 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.

Test required. See Appendix B – Test 6.a.

Latency test may be used as an alternate means of compliance in place of the transport delay test.

Attachment G of Part II provides guidance for transport delay test methodology and also latency.
<table>
<thead>
<tr>
<th>Feature</th>
<th>Technical Requirement</th>
<th>MISCELLANEOUS</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.8 S</td>
<td>Transport delay:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A transport delay test may be used to demonstrate that the FSTD system response does not exceed 100 ms.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>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 aeroplane 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.</td>
</tr>
<tr>
<td>13.8 R,G</td>
<td>Transport delay:</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td>Results required for applicable systems only.</td>
</tr>
<tr>
<td></td>
<td>A transport delay test may be used to demonstrate that the FSTD system response does not exceed 200 ms.</td>
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</tbody>
</table>
Appendix B

VALIDATION TESTS FOR FEATURE FIDELITY LEVELS

For detailed information for these tests refer to Part II, Appendix B, paragraphs 1 to 3.

Note.— Where a validation test has a dependency upon more than one FSTD fidelity feature and it is important for these fidelity levels to be the same, the validation test section is annotated to this effect to highlight the importance of the features inter-dependency for cohesive testing.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>PERFORMANCE</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.a</td>
<td>Taxi</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.a</td>
<td>(1) Minimum radius turn.</td>
<td>±0.9 m (3 ft) or ±20% of aeroplane turn radius.</td>
<td>Ground.</td>
<td></td>
<td></td>
<td>✓</td>
<td>Plot both main and nose gear loci and key engine parameter(s). Data for no brakes and the minimum thrust required to maintain a steady turn except for aeroplanes requiring asymmetric thrust or braking to achieve the minimum radius turn.</td>
</tr>
<tr>
<td>1.a</td>
<td>(2) Rate of turn versus nosewheel steering angle (NWA).</td>
<td>±10% or ±2°/s of turn rate.</td>
<td>Ground.</td>
<td></td>
<td></td>
<td>✓</td>
<td>Record for a minimum of two speeds, greater than minimum turning radius speed with one at a typical taxi speed, and with a spread of at least 5 kt.</td>
</tr>
</tbody>
</table>
### Part III. Flight Simulation Feature and Fidelity Level Criteria

### Appendix B. Validation tests for feature fidelity levels

<table>
<thead>
<tr>
<th>1.b</th>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Take-off</td>
<td></td>
<td></td>
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<td></td>
<td>For validation tests in this section the following device features should be to the same fidelity level:</td>
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<td></td>
<td>Flight model;</td>
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<td></td>
<td></td>
<td>Ground handling;</td>
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<td></td>
<td></td>
<td>Flight controls and forces; and</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Aeroplane systems.</td>
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<td></td>
<td>Note.— All aeroplane manufacturer commonly-used certificated take-off flap settings should be demonstrated at least once either in minimum unstick speed (1.b.3), normal take-off (1.b.4), critical engine failure on take-off (1.b.5) or crosswind take-off (1.b.6).</td>
</tr>
<tr>
<td>1.b</td>
<td>(1) Ground acceleration time and distance.</td>
<td>For level S:</td>
<td>Take-off.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓ Acceleration time and distance should be recorded for a minimum of 80% of the total time from brake release to ( V_r ). May be combined with normal take-off (1.b.4) or rejected take-off (1.b.7). Plotted data should be shown using appropriate scales for each portion of the manoeuvre.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.5 sec or ±5% time; and</td>
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<td></td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td></td>
<td></td>
<td>±61 m (200 ft) or ±5% of distance.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
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<tr>
<td></td>
<td></td>
<td>For level R or R1:</td>
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<td></td>
<td>±1.5 sec or ±5% of time</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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<tr>
<td>1.b (2)</td>
<td>Minimum control speed, ground ((V_{mca})) using aerodynamic controls only per applicable airworthiness requirement or alternative engine inoperative test to demonstrate ground control characteristics.</td>
<td>±25% of maximum aeroplane lateral deviation reached or ±1.5 m (5 ft). For aeroplanes with reversible flight control systems: ±10% or ±2.2 daN (5 lbf) rudder pedal force.</td>
<td>Take-off.</td>
<td>✓</td>
<td>Engine failure speed should be within ±1 kt of aeroplane engine failure speed. Engine thrust decay should be that resulting from the mathematical model for the engine applicable to the FSTD under test. If the modelled engine is not the same as the aeroplane manufacturer’s flight test engine, a further test may be run with the same initial conditions using the thrust from the flight test data as the driving parameter. To ensure only aerodynamic control, nosewheel steering should be disabled (i.e. castored) or the nosewheel held slightly off the ground. If a (V_{mca}) test is not available, an acceptable alternative is a flight test snap engine deceleration to idle at a speed between (V_1) and (V_1-10) kt, followed by control of heading using aerodynamic control only and recovery should be achieved with the main gear on the ground.</td>
<td></td>
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</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
</tbody>
</table>
| 1.b (3) | Minimum unstick speed ($V_{mu}$) or equivalent test to demonstrate early rotation take-off characteristics. | ±3 kt airspeed.  
±1.5° pitch angle. | Take-off. | ✔ |  |  | V$_{mu}$ is defined as the minimum speed at which the last main landing gear leaves the ground. Main landing gear strut compression or equivalent air/ground signal should be recorded. If a $V_{mu}$ test is not available, alternative acceptable flight tests are a constant high-altitude take-off run through main gear lift-off or an early rotation take-off. If either of these alternative solutions is selected, aft body contact/tail strike protection functionality, if present on the aeroplane, should be active. Record time history data from 10 kt before start of rotation until at least 5 s after the occurrence of main gear lift-off. |
| 1.b (4) | Normal take-off. | ±3 kt airspeed.  
±1.5° pitch angle.  
±1.5° AOA.  
±6 m (20 ft) height.  
For aeroplanes with reversible flight control systems:  
±2.2 daN (5 lbf) or ±10% of column force. | Take-off. | ✔ |  |  | Data required for near maximum certificated take-off mass at mid centre of gravity location and light take-off mass at an aft centre of gravity location. If the aeroplane has more than one certificated take-off configuration, a different configuration should be used for each mass. Record take-off profile from brake release to at least 61 m (200 ft) AGL. The test may be used for ground acceleration time and distance (1.b.1). Plotted data should be shown using appropriate scales for each portion of the manoeuvre. |
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.b</td>
<td>(5) Critical engine failure on take-off.</td>
<td>±3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA. ±6 m (20 ft) height. ±2° roll angle. ±2° side-slip angle. ±3° heading angle. For aeroplanes with reversible flight control systems: ±2.2 daN (5 lbf) or ±10% of column force; ±1.3 daN (3 lbf) or ±10% of wheel force; and ±2.2 daN (5 lbf) or ±10% of rudder pedal force.</td>
<td>Take-off.</td>
<td></td>
<td></td>
<td>✓ Record take-off profile to at least 61 m (200 ft) AGL. Engine failure speed should be within ±3 kt of aeroplane data. Test at near MCTM.</td>
<td></td>
</tr>
</tbody>
</table>
### Part III. Flight Simulation Feature and Fidelity Level Criteria

### Appendix B. Validation tests for feature fidelity levels

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.b</td>
<td>(6) Crosswind take-off.</td>
<td>± 3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA. ±6 m (20 ft) height. ±2° roll angle. ±2° side-slip angle. ±3° heading angle. Correct trends at ground speeds below 40 kt for rudder/pedal and heading angle. For aeroplanes with reversible flight control systems: ±2.2 daN (5 lbf) or ±10% of column force; ±1.3 daN (3 lbf) or ±10% of wheel force; and ±2.2 daN (5 lbf) or ±10% of rudder pedal force.</td>
<td>Take-off</td>
<td>✓</td>
<td></td>
<td>Record take-off profile from brake release to at least 61 m (200 ft) AGL. This test requires test data, including wind profile, for a crosswind component of at least 60% of the aeroplane performance data value measured at 10 m (33 ft) above the highway. Wind components should be provided as headwind and crosswind values with respect to the runway.</td>
<td></td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
<tr>
<td>1.b</td>
<td>Rejected take-off.</td>
<td>Take-off.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Record at mass near MCTM. Speed for reject should be at least 80% of $V_1$. Autobrakes will be used where applicable. Maximum braking effort, auto or manual. Where a maximum braking demonstration is not available, an acceptable alternative is a test using approximately 80% braking and full reverse, if applicable. Time and distance should be recorded from brake release to a full stop. For level R or R1 devices, record time for at least 80% of the time segment from initiation of the rejected take-off to full stop.</td>
<td></td>
</tr>
</tbody>
</table>

For level S:
- ±5% of time or ±1.5 s.
- ±7.5% of distance or ±76 m (250 ft).
For level R or R1:
- ±5% of time or ±1.5 s.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.b</td>
<td>(8) Dynamic engine failure after take-off.</td>
<td>±2°/s or ±20% of body angular rates.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Engine failure speed should be within ±3 kt of aeroplane data. Engine failure may be a snap deceleration to idle. Record hands-off from 5 s before engine failure to +5 s or 30° roll angle, whichever occurs first.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Take-off.</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Note.— For safety considerations, aeroplane flight test may be performed out of ground effect at a safe altitude, but with correct aeroplane configuration and airspeed.</td>
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<tr>
<td>CCA: Test in normal and non-normal control state.</td>
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</tr>
<tr>
<td>1.c</td>
<td>Climb</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td>For validation tests in this section the following device features should be to the same fidelity level: Flight model; Flight controls and forces; and Aeroplane systems.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
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</tr>
<tr>
<td>1.c</td>
<td>(1) Normal climb all engines operating.</td>
<td>±3 kt airspeed. ±0.5 m/s (100 ft/ min) or ±5% of rate of climb.</td>
<td>Clean.</td>
<td></td>
<td></td>
<td></td>
<td>Flight test data is preferred; however, aeroplane performance manual data is an acceptable alternative. Record at nominal climb speed and mid initial climb altitude. FSTD performance is to be recorded over an interval of at least 300 m (1000 ft). For level G, R and R1 devices, this test may be a snapshot test.</td>
</tr>
<tr>
<td>1.c</td>
<td>(2) One-engine-inoperative 2nd segment climb.</td>
<td>±3 kt airspeed. ±0.5 m/s (100 ft/ min) or ±5% of rate of climb, but not less than aeroplane performance data requirements.</td>
<td>2nd segment climb.</td>
<td></td>
<td></td>
<td></td>
<td>Flight test data is preferred; however, aeroplane performance manual data is an acceptable alternative. Record at nominal climb speed. FSTD performance is to be recorded over an interval of at least 300 m (1000 ft). Test at WAT (weight, altitude or temperature) limiting condition. For level G, R and R1 devices, this test may be a snapshot test.</td>
</tr>
<tr>
<td>1.c</td>
<td>(3) One-engine-inoperative en-route climb.</td>
<td>±10% of time. ±10% of distance. ±10% of fuel used.</td>
<td>Clean.</td>
<td></td>
<td></td>
<td>✓</td>
<td>Flight test data or aeroplane performance manual data may be used. Test for at least a 1550 m (5000 ft) segment.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
<tr>
<td>1.c</td>
<td>(4) One-engine-inoperative approach climb for aeroplanes with icing accountability if provided in the aeroplane performance data for this phase of flight. ±3 kt airspeed. ±0.5 m/s (100 ft/ min) or ±5% rate of climb, but not less than aeroplane performance data. Approach.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Flight test data or aeroplane performance manual data may be used. FSTD performance to be recorded over an interval of at least 300 m (1 000 ft). Test near maximum certificated landing mass as may be applicable to an approach in icing conditions. Aeroplane should be configured with all anti-ice and de-ice systems operating normally, gear up and go-around flap. All icing accountability considerations, in accordance with the aeroplane performance data for an approach in icing conditions, should be applied.</td>
</tr>
<tr>
<td>1.d</td>
<td>Cruise/Descent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>For validation tests in this section the following device features should be to the same fidelity level: Flight model; Flight controls and forces; and Aeroplane systems.</td>
</tr>
<tr>
<td>1.d</td>
<td>(1) Level flight acceleration. ±5% of time. Cruise.</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Time required to increase airspeed a minimum of 50 kt, using maximum continuous thrust rating or equivalent. For aeroplanes with a small operating speed range, speed change may be reduced to 80% of operational speed change.</td>
<td></td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1.d (2)</td>
<td>Level flight deceleration.</td>
<td>±5% of time.</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Time required to decrease airspeed a minimum of 50 kt, using idle power.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cruise.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>For aeroplanes with a small operating speed range, speed change may be reduced to 80% of operational speed change.</td>
</tr>
<tr>
<td>1.d (3)</td>
<td>Cruise performance.</td>
<td>±0.05 EPR or ±3% N1 or ±5% of torque.</td>
<td>Cruise.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>The test may be a single snapshot showing instantaneous fuel flow, or a minimum of two consecutive snapshots with a spread of at least 3 minutes in steady flight.</td>
</tr>
<tr>
<td>1.d (4)</td>
<td>Idle descent.</td>
<td>±3 kt airspeed.</td>
<td>Clean.</td>
<td>✓</td>
<td></td>
<td></td>
<td>Idle power stabilized descent at normal descent speed at mid altitude. FSTD performance to be recorded over an interval of at least 300 m (1 000 ft).</td>
</tr>
<tr>
<td>1.d (5)</td>
<td>Emergency descent.</td>
<td>±5 kt airspeed.</td>
<td>As per aeroplane performance data.</td>
<td>✓</td>
<td></td>
<td></td>
<td>Stabilized descent to be conducted with speed brakes extended if applicable, at mid altitude and near $V_{mo}$ or according to emergency descent procedure. FSTD performance to be recorded over an interval of at least 900 m (3 000 ft).</td>
</tr>
<tr>
<td>1.e</td>
<td>Stopping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>For validation tests in this section the following device features should be to the same fidelity level: Flight model; Ground handling; Flight controls and forces; and Aeroplane systems.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
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<td>COMMENTS</td>
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</tr>
<tr>
<td>1.e</td>
<td>(1) Deceleration time and distance, manual wheel brakes, dry runway, no reverse thrust.</td>
<td>±1.5 s or ±5% of time. For distances up to 1 220 m (4 000 ft), the smaller of ±61 m (200 ft) or ±10% of distance. For distances greater than 1 220 m (4 000 ft), ±5% of distance.</td>
<td>Landing.</td>
<td>✓</td>
<td></td>
<td></td>
<td>Time and distance should be recorded for at least 80% of the total time from touchdown to a full stop. Position of ground spoilers and brake system pressure should be plotted (if applicable). Data required for medium and near maximum certificated landing mass. Engineering data may be used for the medium mass condition.</td>
</tr>
<tr>
<td>1.e</td>
<td>(2) Deceleration time and distance, reverse thrust, no wheel brakes, dry runway.</td>
<td>±1.5 s or ±5% of time; and the smaller of ±61 m (200 ft) or ±10% of distance.</td>
<td>Landing.</td>
<td>✓</td>
<td></td>
<td></td>
<td>Time and distance should be recorded for at least 80% of the total time from initiation of reverse thrust to full thrust reverser minimum operating speed. Position of ground spoilers should be plotted (if applicable). Data required for medium and near maximum certificated landing mass. Engineering data may be used for the medium mass condition.</td>
</tr>
<tr>
<td>1.e</td>
<td>(3) Stopping distance, wheel brakes, wet runway.</td>
<td>±61 m (200 ft) or ±10% of distance.</td>
<td>Landing.</td>
<td>✓</td>
<td></td>
<td></td>
<td>Either flight test or manufacturer’s performance manual data should be used, where available. Engineering data, based on dry runway flight test stopping distance and the effects of contaminated runway braking coefficients, are an acceptable alternative.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
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<td>COMMENTS</td>
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<tr>
<td>1.e</td>
<td>(4) Stopping distance, wheel brakes, icy runway.</td>
<td>±61 m (200 ft) or ±10% of distance.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td>✓</td>
<td>Either flight test or manufacturer’s performance manual data should be used, where available. Engineering data, based on dry runway flight test stopping distance and the effects of contaminated runway braking coefficients, are an acceptable alternative.</td>
</tr>
<tr>
<td>1.f</td>
<td>Engines</td>
<td>±10% Ti or ±0.25 s; and ±10% Tt or ±0.25 s.</td>
<td>Approach or landing.</td>
<td></td>
<td></td>
<td>✓</td>
<td>Ti = total time from initial throttle movement until a critical engine parameter reaches 10% of its total response above idle power. Tt = total time from initial throttle movement until a critical engine parameter reaches 90% of its total response above idle power. Total response is the incremental change in the critical engine parameter from idle power to go-around power. Refer to paragraph 3.1, Figure B-1 of Part II, Appendix B.</td>
</tr>
<tr>
<td>1.f</td>
<td>(1) Acceleration.</td>
<td>±10% Ti or ±1 s; and ±10% Tt or ±1 s.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>For level R or R1: ±10% Ti or ±1 s; and ±10% Tt or ±1 s. For level G: ±10% Ti or ±1 s; and ±10% Tt or ±1 s.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>T</td>
<td></td>
<td>M</td>
<td></td>
</tr>
</tbody>
</table>

C, T, & M refer to Part II, Appendix B.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
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<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.f</td>
<td>(2) Deceleration.</td>
<td>±10% Ti or ±0.25 s; and ±10% Tt or ±0.25 s.</td>
<td>Ground.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
|      |           | For level R or R1 devices: | | | ✓ | ✓ | Ti = total time from initial throttle movement until a critical engine parameter reaches 10% of its total response below maximum take-off power.  
Tt = total time from initial throttle movement until a critical engine parameter reaches 90% of its total response below maximum take-off power.  
Total response is the incremental change in the critical engine parameter from maximum take-off power to idle power. | | | |
<p>|      |           | ±10% Ti or ± 1 s; and ±10% Tt or ± 1 s. | | | | | |
|      |           | For level G devices: | | | | | Refer to paragraph 3.1, Figure B-2 of Part II, Appendix B. | | |
|      |           | ±10% Ti or ± 1 s; and ±10% Tt or ± 1 s. | | | | | |</p>
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
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<th>S</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>HANDLING QUALITIES</td>
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</tr>
</tbody>
</table>

Note 1. — Pitch, roll and yaw 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 aeroplane data. Provided that 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. 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. Such a permanent installation could be used without any time being lost for the installation of external devices. Static and dynamic flight control tests should be accomplished at the same feel or impact pressures as the validation data where applicable.

Note 2. — FSTD testing from the second set of pilot controls is only required 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.

2.a Static control checks

Note. — Testing of position versus force is not applicable if forces are generated solely by use of aeroplane hardware in the FSTD.

2.a (1) Pitch controller position versus force and surface position calibration. ±0.9 daN (2 lbf) breakout. ±2.2 daN (5 lbf) or ±10% of force. ±2° elevator angle. Ground. ✔ ✔ Uninterrupted control sweep to stops. Test results should be validated with in-flight data from tests such as longitudinal static stability, stalls, etc.

Approach. C T M C T M Control forces and travel should broadly correspond to that of the replicated class of aeroplane.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
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<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.a</td>
<td>(2) Roll controller position versus force and surface position calibration.</td>
<td>±0.9 daN (2 lbf) breakout. ±1.3 daN (3 lbf) or ±10% of force. ±2° aileron angle. ±3° spoiler angle.</td>
<td>Ground.</td>
<td>C</td>
<td>T</td>
<td>&amp;</td>
<td>Uninterrupted control sweep to stops. Test results should be validated with in-flight data from tests such as engine-out trims, steady state side-slips, etc.</td>
</tr>
<tr>
<td></td>
<td>Roll controller position versus force.</td>
<td>±0.9 daN (2 lbf) breakout. ±1.3 daN (3 lbf) or ±10% of force.</td>
<td>Approach.</td>
<td>C</td>
<td>T</td>
<td>&amp;</td>
<td>Control forces and travel need to broadly correspond to that of the replicated class of aeroplane.</td>
</tr>
<tr>
<td>2.a</td>
<td>(3) Rudder pedal position versus force and surface position calibration.</td>
<td>±2.2 daN (5 lbf) breakout. ±2.2 daN (5 lbf) or ±10% of force. ±2° rudder angle.</td>
<td>Ground.</td>
<td>C</td>
<td>T</td>
<td>&amp;</td>
<td>Uninterrupted control sweep to stops. Test results should be validated with in-flight data from tests such as engine-out trims, steady state side-slips, etc.</td>
</tr>
<tr>
<td></td>
<td>Rudder pedal position versus force.</td>
<td>±2.2 daN (5 lbf) breakout. ±2.2 daN (5 lbf) or ±10% of force.</td>
<td>Approach.</td>
<td>C</td>
<td>T</td>
<td>&amp;</td>
<td>Control forces and travel need to broadly correspond to that of the replicated class of aeroplane.</td>
</tr>
<tr>
<td>2.a</td>
<td>(4) Nosewheel steering controller force and position calibration.</td>
<td>±0.9 daN (2 lbf) breakout. ±1.3 daN (3 lbf) or ±10% of force. ±2° NWA.</td>
<td>Ground.</td>
<td>C</td>
<td>T</td>
<td>&amp;</td>
<td>Uninterrupted control sweep to stops.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
<tr>
<td>2.a</td>
<td>(5) Rudder pedal steering calibration.</td>
<td>±2° NWA.</td>
<td>Ground.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>Uninterrupted control sweep to stops.</td>
</tr>
<tr>
<td>2.a</td>
<td>(6) Pitch trim versus surface position calibration.</td>
<td>±0.5° trim angle.</td>
<td>Ground.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>The purpose of the test is to compare FSTD surface position and indicator against the software value.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.0° trim angle.</td>
<td>Ground.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
</tr>
<tr>
<td>2.a</td>
<td>(7) Pitch trim rate.</td>
<td>±10% of trim rate (°/s) or ±0.1°/s trim rate.</td>
<td>Ground and approach.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>Trim rate to be checked at pilot primary induced trim rate (ground) and autopilot or pilot primary trim rate in-flight at go-around flight conditions. For CCA, representative flight test conditions should be used.</td>
</tr>
</tbody>
</table>
## Flight Simulation Feature and Fidelity Level Criteria

### Appendix B. Validation tests for feature fidelity levels

#### III-App B-19

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.a</td>
<td>(8) Alignment of cockpit throttle lever versus selected engine parameter.</td>
<td>When matching engine parameters: ±5° of TLA. When matching detents: ±3% N1 or ±0.03 EPR or ±3% torque, or equivalent. Where the levers do not have angular travel, a tolerance of ±2 cm (±0.8 in) applies.</td>
<td>Ground.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Simultaneous recording for all engines. The tolerances apply against aeroplane data. For aeroplanes with throttle detents, all detents to be presented and at least one position between detents/endpoint (where practical). For aeroplanes without detents, end points and at least three other positions are to be presented. Data from a test aeroplane or engineering test bench are acceptable, provided the correct engine controller (both hardware and software) is used. In the case of propeller-driven aeroplanes, if an additional lever, usually referred to as the propeller lever, is present, it should also be checked. This test may be a series of snapshot tests.</td>
</tr>
<tr>
<td>2.a</td>
<td>(9) Brake pedal position versus force and brake system pressure calibration.</td>
<td>±2.2 daN (5 lbf) or ±10% of force. ±1.0 MPa (150 psi) or ±10% of brake system pressure. For level R &amp; R1: ±2.2 daN (5 lbf) or ±10% of force.</td>
<td>Ground.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>FSTD computer output results may be used to show compliance. Relate the hydraulic system pressure to pedal position in a ground static test. Both left and right pedals should be checked.</td>
</tr>
</tbody>
</table>

FSTD computer output results may be used to show compliance.
### Dynamic control checks

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
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<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.b</td>
<td>Dynamic control checks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.**— Tests 2.b.1, 2.b.2 and 2.b.3 are not applicable for FSTDs where the control forces are completely generated within the aeroplane controller unit installed in the FSTD. Power setting may be that required for level flight unless otherwise specified. See paragraph 3.2 of Part II, Appendix B.

2.b (1) Pitch control. (ctd next page)

**For underdamped systems** (as per Figure B-3 of Part II, Appendix B):

- \( T(P_0) \pm 10\% \) of \( P_0 \) or \( \pm 0.05 \) s.
- \( T(P_1) \pm 20\% \) of \( P_1 \) or \( \pm 0.05 \) s.
- \( T(P_2) \pm 30\% \) of \( P_2 \) or \( \pm 0.05 \) s.
- \( T(P_n) \pm 10\% \) of \( A_{\text{max}} \), where \( A_{\text{max}} \) is the largest amplitude or \( \pm 0.5\% \) of the total control travel (stop to stop).
- \( T(A_0) \pm 5\% \) of \( A_d \), where \( A_d \) = residual band or \( \pm 0.5\% \) of the maximum control travel = residual band.

*Take-off, cruise and landing.*

- \( T(A_d) \pm 5\% \) of \( A_d \) = residual band or \( \pm 0.5\% \) of the maximum control travel = residual band. ±1 significant overshoots (minimum of 1 significant overshoot).

Data should be for normal control displacements in both directions (approximately 25% to 50% of full throw or approximately 25% to 50% of maximum allowable pitch controller deflection for flight conditions limited by the manoeuvring load envelope).

Tolerances apply against the absolute values of each period (considered independently).

\( n = \) the sequential period of a full oscillation.

Refer to paragraphs 3.2.2, 3.2.3, 3.2.4 and 3.2.5 of Part II, Appendix B.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Steady state position within residual band.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Note 1. – Tolerances should not be applied on period or amplitude after the last significant overshoot.</td>
<td></td>
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<tr>
<td></td>
<td>Note 2. – Oscillations within the residual band are not considered significant and are not subject to tolerances.</td>
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</tr>
<tr>
<td>2.b (2)</td>
<td>Roll control.</td>
<td>Same as 2.b.1.</td>
<td>Take-off, cruise and landing.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>For overdamped and critically damped systems only, the following tolerance applies:</td>
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<td></td>
<td></td>
<td></td>
<td>For overdamped and critically damped systems, see Figure B-4 of Part II, Appendix B for an illustration of the reference measurement.</td>
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</tr>
<tr>
<td></td>
<td>( T(P_0) \pm 10% \text{ of } P_0 ) or ( \pm 0.05 \text{ s.} )</td>
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</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2.b (3)</td>
<td>Yaw control. Same as 2.b.1.</td>
<td>Take-off, cruise and landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Data should be for normal control displacement (approximately 25% to 50% of full throw). Refer to paragraphs 3.2.2, 3.2.3, 3.2.4 and 3.2.5 of Part II, Appendix B.</td>
</tr>
<tr>
<td>2.b (4)</td>
<td>Small control inputs — pitch. ±0.15°/s body pitch rate or ±20% of peak body pitch rate applied throughout the time history.</td>
<td>Approach or landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0.5 to 2°/s pitch rate). Test in both directions. Show time history data from 5 s before until at least 5 s after initiation of control input. If a single test is used to demonstrate both directions, there should be a minimum of 5 s before control reversal to the opposite direction. <strong>CCA:</strong> Test in normal and non-normal control state.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
<tr>
<td>2.b (5) Small control inputs — roll.</td>
<td>±0.15°/s body roll rate or ±20% of peak body roll rate applied throughout the time history.</td>
<td>Approach or landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0.5 to 2°/s roll rate). Test in one direction. For aeroplanes that exhibit non-symmetrical behaviour, test in both directions. Show time history data from 5 s before until at least 5 s after initiation of control input. If a single test is used to demonstrate both directions, there should be a minimum of 5 s before control reversal to the opposite direction. <strong>CCA:</strong> Test in normal and non-normal control state.</td>
</tr>
<tr>
<td>2.b (6) Small control inputs — yaw.</td>
<td>±0.15°/s body yaw rate or ±20% of peak body yaw rate applied throughout the time history.</td>
<td>Approach or landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Control inputs should be typical of minor corrections made while established on an ILS approach (approximately 0.5 to 2°/s yaw rate). Test in both directions. Show time history data from 5 s before until at least 5 s after initiation of control input. If a single test is used to demonstrate both directions, there should be a minimum of 5 s before control reversal to the opposite direction. <strong>CCA:</strong> Test in normal and non-normal control state.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
<tr>
<td>2.c</td>
<td>Longitudinal</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>±3 kt airspeed.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>±30 m (100 ft) altitude.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td></td>
<td></td>
<td>±1.5° or ±20% of pitch angle.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Approach.</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Power change from thrust for approach or level flight to maximum continuous or go-around power.</td>
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<tr>
<td></td>
<td></td>
<td>Time history of uncontrolled free response for a time increment equal to at least 5 s before initiation of the power change to the completion of the power change + 15 s.</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td><strong>CCA:</strong> Test in normal and non-normal control mode for level S devices. For level G, R and R1 devices, test in normal mode only.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OR for level G devices:</td>
<td></td>
<td>C</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1) Power change force.</td>
<td>±2.2 daN (5 lbf) or ±20% of pitch controller force.</td>
<td>T &amp; M</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Force tests (level G devices) should provide the force required to maintain constant airspeed or altitude to complete the configuration change.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>TEST</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
<tr>
<td>2.c</td>
<td>(2) Flap change dynamics.</td>
<td>±3 kt airspeed. ±30 m (100 ft) altitude. ±1.5° or ±20% of pitch angle.</td>
<td>Take-off through initial flap retraction, and approach to landing.</td>
<td>C T &amp; M</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>OR for level G devices:</td>
<td>±2.2 daN (5 lbf) or ±20% of pitch controller force.</td>
<td>C T &amp; M</td>
<td>✓</td>
<td>✓</td>
<td>Force tests (level G devices) should provide the force required to maintain constant airspeed or altitude to complete the configuration change.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.c</td>
<td>(3) Spoiler/speedbrake change dynamics.</td>
<td>±3 kt airspeed. ±30 m (100 ft) altitude. ±1.5° or ±20% of pitch angle.</td>
<td>Cruise.</td>
<td>C T &amp; M</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
<tr>
<td>2.c</td>
<td>(4) Gear change dynamics. ±3 kt airspeed. ±30 m (100 ft) altitude. ±1.5° or ±20% of pitch angle.</td>
<td>Take-off (retraction) and approach (extension).</td>
<td>C</td>
<td>T &amp; M</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>OR for level G devices: (4) Gear change force. ±2.2 daN (5 lbf) or ±20% of pitch controller force.</td>
<td></td>
<td>C</td>
<td>T &amp; M</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CCA:** Test in normal and non-normal control mode for level S devices. For level G, R and R1 devices, test in normal mode only.

Force tests (level G devices) should provide the force required to maintain constant airspeed or altitude to complete the configuration change.
### Part III. Flight Simulation Feature and Fidelity Level Criteria

#### Appendix B. Validation tests for feature fidelity levels

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.c</td>
<td>(5) Longitudinal trim.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>For level S devices:</td>
<td>±1° elevator angle.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Steady-state wings level trim with thrust for level flight. This test may be a series of snapshot tests.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.5° stabilizer angle.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>±1° pitch angle.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>±5% of net thrust or equivalent.</td>
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</tr>
<tr>
<td></td>
<td>For level R &amp; R1 devices:</td>
<td>±2° elevator angle.</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1° stabilizer angle.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>±2° pitch angle.</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>±5% of net thrust or equivalent.</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>For level G devices:</td>
<td>±2° elevator angle.</td>
<td>C</td>
<td>T &amp; M</td>
<td></td>
<td></td>
<td>Level R and R1 devices may use pitch controller position instead of elevator angle and trim control position instead of stabilizer angle.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1° stabilizer angle.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2° pitch angle.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>±5% of net thrust or equivalent.</td>
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</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<td>R</td>
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</tr>
<tr>
<td>2.c</td>
<td>(6) Longitudinal maneouvrung stability (stick force/g).</td>
<td>±2.2 daN (5 lbf) or ±10% of pitch controller force.</td>
<td>Cruise, approach and landing.</td>
<td>C</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
</tr>
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<td></td>
<td>T</td>
<td>T</td>
<td>&amp;</td>
<td>M</td>
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<td>&amp;</td>
<td>&amp;</td>
<td>M</td>
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</tr>
</tbody>
</table>

Alternative method: ±1° or ±10% of the change of elevator angle.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
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<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.c</td>
<td>(7) Longitudinal static stability.</td>
<td>±2.2 daN (5 lbf) or ±10% of pitch controller force.</td>
<td>Approach.</td>
<td>C</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
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<td>T</td>
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<td>M</td>
<td>M</td>
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</tbody>
</table>

Alternative method: ±1° or ±10% of the change of elevator angle.
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<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.c</td>
<td>(8) Stall characteristics.</td>
<td>±3 kt airspeed for initial buffet, stall warning, and stall speeds.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>±2° roll angle for speeds greater than stick shaker or initial buffet.</td>
<td></td>
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<td></td>
<td></td>
<td>For aeroplanes with reversible flight control systems:</td>
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<tr>
<td></td>
<td></td>
<td>±10% or ±2.2 daN (5 lbf) column force (prior to g-break only).</td>
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<tr>
<td></td>
<td></td>
<td>For level R, R1 and G devices (the manoeuvre need not include full stall):</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>±3 kt airspeed for stall warning.</td>
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<td></td>
<td></td>
<td>2nd segment climb and approach or landing.</td>
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<td></td>
<td></td>
<td>C T M</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Wings-level (1 g) stall entry with thrust at or near idle power.</td>
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<td></td>
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<td></td>
<td>Time history data should be shown to include full stall and initiation of recovery.</td>
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<td></td>
<td>Stall warning signal should be recorded and should occur in the proper relation to stall.</td>
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<td></td>
<td>FSTDs for aeroplanes exhibiting a sudden pitch attitude change or &quot;g-break&quot; should demonstrate this characteristic.</td>
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<td></td>
<td></td>
<td>CCA: Test in normal and non-normal control mode for level S devices, as applicable. For level R, R1 and G devices test in normal mode only, if applicable.</td>
<td></td>
</tr>
</tbody>
</table>
### Part III. Flight Simulation Feature and Fidelity Level Criteria

#### Appendix B. Validation tests for feature fidelity levels III-App B-31

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.c</td>
<td>(9) Phugoid dynamics.</td>
<td>±10% of period. ±10% of time to one half or double amplitude or ±0.02 of damping ratio. For level R, R1 and G devices: ±10% of period, with representative damping. Cruise.</td>
<td>C</td>
<td>T &amp; M</td>
<td>✓</td>
<td>✓</td>
<td>✓ Test should include three full cycles or that necessary to determine time to one half or double amplitude, whichever is less. CCA: Test in non-normal control mode.</td>
</tr>
<tr>
<td>2.c</td>
<td>(10) Short period dynamics.</td>
<td>±1.5° pitch angle or ±2°/s pitch rate. ±0.1 g normal acceleration. Cruise.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓ CCA: Test in normal and non-normal control mode.</td>
</tr>
<tr>
<td>2.d</td>
<td>Lateral directional</td>
<td></td>
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<td></td>
<td>For validation tests in this section the following device features should be to the same fidelity level: Flight model; Flight controls and forces; and Aeroplane systems. Note.— Power setting may be that required for level flight unless otherwise specified.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
<tr>
<td>2.d (1) Minimum control speed, air ( V_{mca} ) or landing ( V_{mcl} ), per applicable airworthiness requirement or low speed engine-inoperative handling characteristics in the air.</td>
<td>±3 kt airspeed.</td>
<td>Take-off or landing (whichever is most critical in the aeroplane).</td>
<td>C</td>
<td>T &amp; M</td>
<td>C</td>
<td>✓</td>
<td>Minimum speed may be defined by a performance or control limit which prevents demonstration of ( V_{mca} ) or ( V_{mcl} ) in the conventional manner. Take-off thrust should be set on the operating engine(s). Time history or snapshot data may be used. For level G R, and R1 devices, it is important that there exists a realistic speed relationship between ( V_{mca} ) ( V_{mcl} ) and ( V_s ) for all configurations and in particular the most critical full-power engine-out configuration. CCA: Test in normal or non-normal control state, as applicable.</td>
</tr>
<tr>
<td>2.d (2) Roll response (rate).</td>
<td>±2°/s or ±10% of roll rate.</td>
<td>Cruise and approach or landing.</td>
<td>C</td>
<td>T &amp; M</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

For aeroplanes with reversible flight control systems:

±1.3 daN (3 lbf) or ±10% of wheel force.
<table>
<thead>
<tr>
<th></th>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.d</td>
<td>(3) Step input of flight deck roll controller.</td>
<td>±2° or ±10% of roll angle.</td>
<td>Approach or landing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>With wings level, apply a step roll control input using approximately one-third of maximum roll controller travel. At approximately 20° to 30° roll angle, abruptly return the roll controller to neutral and allow at least 10 s of aeroplane free response. This test may be combined with roll response (rate) test 2.d.2. CCA: Test in normal and non-normal control mode for level S devices. For level R devices test in normal mode only.</td>
<td></td>
</tr>
<tr>
<td>2.d</td>
<td>(4) Spiral stability.</td>
<td>Correct trend and ±2° or ±10% of roll angle in 20 s.</td>
<td>Cruise and approach or landing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Aeroplane data averaged from multiple tests may be used. Test for both directions. As an alternative test, show lateral control required to maintain a steady turn with a roll angle of approximately 30°. CCA: Test in non-normal control mode.</td>
<td></td>
</tr>
</tbody>
</table>

If alternate test is used: correct trend and ±2° aileron angle.

For level G, R, and R1 devices:
Correct trend and ±3° or ±10% of roll angle in 20 s.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.d</td>
<td>(5) Engine-inoperative trim.</td>
<td>±1° rudder angle or ±1° tab angle or equivalent rudder pedal. ±2° side-slip angle.</td>
<td>2nd segment climb and approach or landing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Test should be performed in a manner similar to that for which a pilot is trained to trim an engine failure condition. 2nd segment climb test should be at take-off thrust. Approach or landing test should be at thrust for level flight. This test may consist of snapshot tests. For R and R1: Side-slip angle is matched only for repeatability and only on continuing recurrent evaluations.</td>
</tr>
<tr>
<td>2.d</td>
<td>(6) Rudder response.</td>
<td>±2°/s or ±10% of yaw rate.</td>
<td>Approach or landing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Test with stability augmentation on and off. Test with a step input at approximately 25% of full rudder pedal throw. <strong>CCA</strong>: Test in normal and non-normal control mode for level S devices. For level G, R and R1 devices, test in normal mode only.</td>
</tr>
<tr>
<td></td>
<td>Or for level G devices:</td>
<td>±2°/s or ±10% of yaw rate or ±10% of heading change.</td>
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</tbody>
</table>

**CCA**: Causation, Controllability, Acceptability.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>
| 2.d  | (7) Dutch roll. | ±0.5 s or ±10% of period. 
±10% of time to one half or double amplitude or ±0.02 of damping ratio. 
±1 s or ±20% of time difference between peaks of roll angle and side-slip angle. |   |   | ✓ | ✓ | Test for at least six cycles with stability augmentation off. 
CCA: Test in non-normal control mode. |
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.d</td>
<td>(8) Steady state sideslip.</td>
<td>For a given rudder position: ±2° roll angle; ±1° side-slip angle; ±2° or ±10% of aileron angle; and ±5° or ±10% of spoiler or equivalent roll controller position or force.</td>
<td>Approach or landing.</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

For aeroplanes with reversible flight control systems: ±1.3 daN (3 lbf) or ±10% of wheel force. ±2.2 daN (5 lbf) or ±10% of rudder pedal force. | C | C | ✓ | ✓ | | |
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.e Landings</td>
<td>±3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA. ±3 m (10 ft) or ±10% of height. For aeroplanes with reversible flight control systems: ±2.2 daN (5 lbf) or ±10% of column force.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>For validation tests in this section the following device features should be to the same fidelity level: Flight model; Ground handling; Flight controls and forces; and Aeroplane systems.</td>
</tr>
<tr>
<td>2.e (1) Normal landing</td>
<td>Test from a minimum of 61 m (200 ft) AGL to nosewheel touchdown. Two tests should be shown, including two normal landing flaps (if applicable) one of which should be near maximum certificated landing mass, the other at light or medium mass. CCA: Test in normal and non-normal control mode, if applicable.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Test from a minimum of 61 m (200 ft) AGL to nosewheel touchdown. Two tests should be shown, including two normal landing flaps (if applicable) one of which should be near maximum certificated landing mass, the other at light or medium mass. CCA: Test in normal and non-normal control mode, if applicable.</td>
</tr>
<tr>
<td>2.e (2) Minimum flap landing</td>
<td>Test at near maximum certificated landing mass.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Test at near maximum certificated landing mass.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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</tr>
<tr>
<td>2.e</td>
<td>(3) Crosswind landing.</td>
<td>±3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA. ±3 m (10 ft) or ±10% of height. ±2° roll angle. ±2° side-slip angle. ±3° heading angle. For aeroplanes with reversible flight control systems: ±2.2 daN (5 lbf) or ±10% of column force. ±1.3 daN (3 lbf) or ±10% of wheel force. ±2.2 daN (5 lbf) or ±10% of rudder pedal force.</td>
<td>Landing.</td>
<td>✓</td>
<td>Test from a minimum of 61 m (200 ft) AGL to a 50% decrease in main landing gear touchdown speed. It requires test data, including wind profile, for a crosswind component of at least 60% of aeroplane performance data value measured at 10 m (33 ft) above the runway. Wind components should be provided as headwind and crosswind values with respect to the runway.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.e</td>
<td>(4) One-engine-inoperative landing.</td>
<td>±3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA. ±3 m (10 ft) or ±10% of height. ±2° roll angle. ±2° side-slip angle. ±3° heading angle.</td>
<td>Landing.</td>
<td>✓</td>
<td>Test from a minimum of 61 m (200 ft) AGL to a 50% decrease in main landing gear touchdown speed.</td>
<td></td>
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</tr>
</tbody>
</table>
### Part III. Flight Simulation Feature and Fidelity Level Criteria

#### Appendix B. Validation tests for feature fidelity levels

<table>
<thead>
<tr>
<th>Test</th>
<th>Tolerance Details</th>
<th>Flight Condition</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.e (5) Autopilot landing (if applicable).</td>
<td>±1.5 m (5 ft) flare height. ±2° roll angle. ±3 m (10 ft) lateral deviation during roll-out.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>If autopilot provides roll-out guidance, record lateral deviation from touchdown to a 50% decrease in main landing gear touchdown speed. Time of autopilot flare mode engage and main gear touchdown should be noted. Tf = duration of flare.</td>
</tr>
<tr>
<td>2.e (6) All-engine autopilot go-around.</td>
<td>±3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA.</td>
<td>As per aeroplane performance data.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Normal all-engine autopilot go-around should be demonstrated (if applicable) at medium mass.</td>
</tr>
<tr>
<td>2.e (7) One-engine-inoperative go-around.</td>
<td>±3 kt airspeed. ±1.5° pitch angle. ±1.5° AOA. ±2° roll angle. ±2° side-slip angle.</td>
<td>As per aeroplane performance data.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Engine inoperative go-around required near maximum certificated landing mass with critical engine inoperative. Provide one test with autopilot (if applicable) and one without autopilot. <strong>CCA</strong>: Non-autopilot test to be conducted in non-normal mode.</td>
</tr>
<tr>
<td>2.e (8) Directional control (rudder effectiveness) with reverse thrust (symmetric).</td>
<td>±5 kt airspeed. ±2°/s yaw rate.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Apply rudder pedal input in both directions using full reverse thrust until reaching full thrust reverser minimum operating speed.</td>
</tr>
<tr>
<td>2.e (9) Directional control (rudder effectiveness) with reverse thrust (asymmetric).</td>
<td>±5 kt airspeed. ±3° heading angle.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>With full reverse thrust on the operating engine(s), maintain heading with rudder pedal input until maximum rudder pedal input or thrust reverser minimum operation speed is reached.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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<tr>
<td>2.f</td>
<td>Ground effect</td>
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</tr>
<tr>
<td>2.f</td>
<td>(1) A test to demonstrate ground effect.</td>
<td>±1° elevator angle.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td>✓</td>
<td>See paragraph 3.3.2 of Part II, Appendix B. A rationale should be provided with justification of results. CCA: Test in normal or non-normal control mode, as applicable.</td>
</tr>
<tr>
<td>2.g</td>
<td>Wind shear</td>
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</tr>
<tr>
<td>2.g</td>
<td>(1) A test to demonstrate wind shear models.</td>
<td>None.</td>
<td>Take-off and landing.</td>
<td></td>
<td></td>
<td>✓</td>
<td>See Appendix A of this Part, Requirement 11.2.</td>
</tr>
</tbody>
</table>

For validation tests in this section the following device features should be to the same fidelity level:
- Flight model;
- Flight controls and forces; and
- Aeroplane systems.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.h</td>
<td>Flight and manoeuvre envelope protection functions</td>
<td>±5 kt airspeed.</td>
<td>Cruise.</td>
<td></td>
<td></td>
<td></td>
<td>For validation tests in this section the following device features should be to the same fidelity level: Flight model; Flight controls and forces; and Aeroplane systems. Note.— The requirements of 2.h are only applicable to computer-controlled aeroplanes. Time history results of response to control inputs during entry into each envelope protection function (i.e. with normal and degraded control states if function is different) are required. Set thrust as required to reach the envelope protection function.</td>
</tr>
<tr>
<td>2.h</td>
<td>(1) Overspeed.</td>
<td>±3 kt airspeed.</td>
<td>Take-off, cruise and approach or landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>2.h</td>
<td>(2) Minimum speed.</td>
<td>±0.1 g normal acceleration.</td>
<td>Take-off, cruise.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>2.h</td>
<td>(3) Load factor.</td>
<td>±1.5° pitch angle.</td>
<td>Cruise, approach.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>2.h</td>
<td>(4) Pitch angle.</td>
<td>±2° or ±10% of roll angle.</td>
<td>Approach.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>2.h</td>
<td>(5) Roll angle.</td>
<td>±1.5° AOA.</td>
<td>2nd segment and approach or landing.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>2.h</td>
<td>(6) Angle of attack.</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
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<td>--------------------------------------------------------------------------</td>
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<tr>
<td>3. MOTION SYSTEM</td>
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</tr>
<tr>
<td>3.a Frequency response.</td>
<td>As specified by the applicant for FSTD qualification.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Appropriate test to demonstrate required frequency response.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>See also paragraph 3.5.2 of Part II, Appendix B.</td>
</tr>
<tr>
<td>Leg balance.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not applicable.</td>
</tr>
<tr>
<td>3.b Turn-around check.</td>
<td>As specified by the applicant for FSTD qualification.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Appropriate test to demonstrate required smooth turn-around.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>See also paragraph 3.5.2 of Part II, Appendix B.</td>
</tr>
<tr>
<td>3.c Motion effects.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Refer to Appendix C of this Part on subjective testing.</td>
</tr>
<tr>
<td>3.d Motion system</td>
<td>±0.05 g actual platform linear accelerations.</td>
<td>None.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>This test ensures that motion system hardware and software (in normal</td>
</tr>
<tr>
<td>repeatability.</td>
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<td></td>
<td>FSTD operating mode) continue to perform as originally qualified.</td>
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<td>Performance changes from the original baseline can be readily identified</td>
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<td>with this information.</td>
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<td></td>
<td></td>
<td>See paragraph 3.5.4 of Part II, Appendix B.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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</tr>
<tr>
<td>3.e</td>
<td>(1) Motion cueing fidelity - Frequency-domain criterion.</td>
<td>TBD.</td>
<td>Ground and flight.</td>
<td></td>
<td></td>
<td>✓</td>
<td>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 simulated aircraft. See paragraph 3.5.3 of Part II, Appendix B. Appropriate test tolerances are currently being tested and evaluated through the ICFQ mechanism (refer to Appendix D of Part II).</td>
</tr>
<tr>
<td>3.e</td>
<td>(2) Motion cueing fidelity - Time-domain criterion</td>
<td>TBD.</td>
<td>Ground and flight.</td>
<td></td>
<td></td>
<td>✓</td>
<td>Appropriate testing criterion and tolerances are currently being tested and evaluated through the ICFQ mechanism (refer to Appendix D of Part II).</td>
</tr>
<tr>
<td>3.f</td>
<td>Characteristic motion vibrations. The following tests with recorded results and an SOC are required for characteristic motion vibrations, which can be sensed at the flight deck where applicable by aeroplane type.</td>
<td>None.</td>
<td>Ground and flight.</td>
<td></td>
<td></td>
<td></td>
<td>The recorded test results for characteristic buffets should allow the comparison of relative amplitude versus frequency. See paragraph 3.5.5 of Part II, Appendix B. For level R1 devices, footprint test results are required.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<tr>
<td>3.f</td>
<td>(1) Thrust effects with brakes set.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data.</td>
<td>Ground.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Test should be conducted at maximum possible thrust with brakes set.</td>
</tr>
<tr>
<td>3.f</td>
<td>(2) Landing gear extended buffet.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data.</td>
<td>Flight.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Test condition should be for a normal operational speed and not at the gear limiting speed.</td>
</tr>
<tr>
<td>3.f</td>
<td>(3) Flaps extended buffet.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data.</td>
<td>Flight.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Test condition should be at a normal operational speed and not at the flap limiting speed.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<tr>
<td>3.f</td>
<td>(4) Speedbrake deployed buffet.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data.</td>
<td>Flight.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Test condition should be at a typical speed for a representative buffet.</td>
</tr>
</tbody>
</table>
| 3.f  | (5) Approach to stall buffet. | The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data. | Flight. | ✓ | ✓ | | Test condition should be at approach to stall.  
Post-stall characteristics are not required. |
<p>| 3.f  | (6) High speed or Mach buffet. | The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency “spikes” being present within ± 2 Hz of the aeroplane data. | Flight. | ✓ | ✓ | | Test condition should be for high-speed manoeuvre buffet/wind-up-turn or alternatively Mach buffet. |</p>
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
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<tbody>
<tr>
<td>3.f</td>
<td>(7) In-flight vibrations.</td>
<td>The FSTD test results should exhibit the overall appearance and trends of the aeroplane data, with at least three (3) of the predominant frequency &quot;spikes&quot; being present within ± 2 Hz of the aeroplane data.</td>
<td>Flight in clean configuration.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Test should be conducted to be representative of in-flight vibrations for propeller-driven aeroplanes.</td>
</tr>
<tr>
<td>4.</td>
<td>VISUAL SYSTEM</td>
<td></td>
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<td></td>
<td>The validation tests in this section have a dependency upon the following simulation features: Visual cue; and Environment - Airports and terrain.</td>
</tr>
<tr>
<td>4.a</td>
<td>Visual scene quality</td>
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</tr>
<tr>
<td>4.a.1</td>
<td>Continuous collimated cross-cockpit visual field of view.</td>
<td>Cross-cockpit, collimated visual display providing each pilot with a minimum of 200° horizontal and 40° vertical continuous field of view.</td>
<td>Not applicable.</td>
<td></td>
<td>✓</td>
<td></td>
<td>Field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5° squares. Installed alignment should be confirmed in an SOC (this would generally consist of results from acceptance testing).</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
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<tr>
<td>4.a.1 (ctd)</td>
<td>Continuous cross-cockpit visual field of view.</td>
<td>Visual display providing each pilot with a minimum of 200° horizontal and 40° vertical continuous field of view.</td>
<td>Not applicable.</td>
<td>✓</td>
<td></td>
<td>Field of view should be measured using a visual test pattern filling the entire visual scene (all channels) consisting of a matrix of black and white 5° squares. Installed alignment should be confirmed in an SOC (this would generally consist of results from acceptance testing).</td>
<td></td>
</tr>
<tr>
<td>Display field of view.</td>
<td>Visual field-of-view for each pilot with a minimum of 45° horizontally and 30° vertically, unless restricted by the type of aeroplane, simultaneously for each pilot.</td>
<td>Not applicable.</td>
<td>✓</td>
<td></td>
<td></td>
<td>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. 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.</td>
<td></td>
</tr>
<tr>
<td>4.a.2. a.1</td>
<td>System geometry – Image position.</td>
<td>From each eyepoint position the centre of the image is between 0° and 2° inboard in the horizontal plane and within +/-0.25° vertically. The difference between the left and right horizontal angles should not exceed 1°.</td>
<td>Not applicable.</td>
<td>✓</td>
<td></td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<tr>
<td>4.a.2. a.2</td>
<td>System geometry – Absolute geometry.</td>
<td>Within the central 200° x 40°, all points on a 5-degree grid should fall within 3° of the design position as measured from each pilot eyepoint.</td>
<td>Not applicable.</td>
<td>✔</td>
<td>Where a system with more than 200° x 40° is supplied, the geometry outside the central area should not have any distracting discontinuities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.a.2. a.3</td>
<td>System geometry – Relative geometry.</td>
<td>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 90° degrees 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: Zone 1: 0.075°/degree; Zone 2: 0.15°/degree; Zone 3: 0.2°/degree.</td>
<td>Not applicable.</td>
<td>✔</td>
<td>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.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.a.2. b</td>
<td>Geometry of image should have no distracting discontinuities</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
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<tr>
<td>TEST</td>
<td>TOLERANCE</td>
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</tr>
<tr>
<td>4.a.3 Surface resolution (object detection).</td>
<td>Not greater than 2 arc minutes.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>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.</td>
</tr>
<tr>
<td>Surface resolution (object detection).</td>
<td>Not greater than 4 arc minutes.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>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. R - excluding PPL and CPL.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<tr>
<td>4.a.4</td>
<td>Light point size.</td>
<td>Not greater than 5 arc minutes.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td>✓</td>
<td>Light point size should be measured using a test pattern consisting of a centrally located single row of white 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.</td>
</tr>
<tr>
<td></td>
<td>Light point size.</td>
<td>Not greater than 8 arc minutes.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td>✓</td>
<td>Light point size should be measured using a test pattern consisting of a centrally located single row of white 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.</td>
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</tbody>
</table>

R - excluding PPL and CPL.
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<th>TEST</th>
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</thead>
</table>
| 4.a.5 | 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/m² (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-cab and flight deck 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. |
<table>
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<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
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<th>COMMENTS</th>
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</thead>
</table>
| 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-cab and flight deck ambient light levels should be as low as possible. |
| Light point contrast ratio. | Not less than 10:1. | Not applicable. |   | ✓ | | Comments as above. 
R – excluding PPL and CPL. |
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>
| 4.a.7| Light point brightness. | Not less than 30 cd/m² (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/m² (5.8 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). |
| 4.a.8| Surface brightness. | Not less than 20 cd/m² (5.8 ft-lamberts) on the display. | Not applicable. | | | ✓ | Surface brightness should be measured on a white raster, 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/m² (4.1 ft-lamberts) on the display. | Not applicable. | ✓ | ✓ | | Surface brightness should be measured on a white raster, measuring the brightness using the 1° spot photometer.  
Light points are not acceptable.  
Use of calligraphic capabilities to enhance raster brightness is acceptable. |
<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>4.a.9 Black level and sequential contrast.</td>
<td>Black intensity: Background brightness – Black polygon brightness &lt; 0.015 cd/m² (0.004 ft-lamberts). Sequential contrast: Maximum brightness – (Background brightness – Black polygon brightness) &gt; 2000:1.</td>
<td>Not applicable.</td>
<td>✓</td>
<td></td>
<td></td>
<td>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 background 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.</td>
<td></td>
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</table>
### Flight Simulation Feature and Fidelity Level Criteria

#### Appendix B. Validation tests for feature fidelity levels

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
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</thead>
<tbody>
<tr>
<td>4.a.10</td>
<td>Motion blur. When a pattern is rotated about the eyepoint at 10°/s, the smallest detectable gap should be 4 arc min or less.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>A test pattern consists of an array of 5 peak white squares with black gaps between them of decreasing width.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>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.</td>
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<td></td>
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<td></td>
<td>The pattern is rotated at the required rate.</td>
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<td></td>
<td>Two arrays of squares should be provided, one rotating in heading and the other in pitch, to provide testing in both axes.</td>
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<td></td>
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<td>A series of stationary numbers identifies the gap number.</td>
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<td><em>Note.— This test can be limited by the display technology. Where this is the case the NAA should be consulted on the limitations.</em></td>
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<td></td>
<td>This test is generally only required for light valve projectors.</td>
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<td></td>
<td>An SOC should be provided if the test is not run, stating why.</td>
</tr>
<tr>
<td>4.a.11</td>
<td>Speckle test. Speckle contrast should be &lt; 10%.</td>
<td>Not applicable.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>An SOC is required describing the test method.</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>This test is generally only required for laser projectors.</td>
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<td></td>
<td></td>
<td>An SOC should be provided if the test is not run, stating why.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
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<tr>
<td>4.b</td>
<td>Head-up Display (HUD)</td>
<td>Static alignment with displayed image. HUD bore sight should align with the centre of the displayed image spherical pattern. Tolerance +/- 6 arc min.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Alignment requirement applies to any HUD system in use or both simultaneously if they are used simultaneously for training.</td>
</tr>
<tr>
<td>4.b.1</td>
<td>Static Alignment.</td>
<td>Static alignment with displayed image. HUD bore sight should align with the centre of the displayed image spherical pattern. Tolerance +/- 6 arc min.</td>
<td>Not applicable.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Alignment requirement only applies to the pilot flying. R – excluding PPL and CPL.</td>
</tr>
<tr>
<td>4.b.2</td>
<td>System display.</td>
<td>All functionality in all flight modes should be demonstrated.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>A statement of the system capabilities should be provided and the capabilities demonstrated. R – excluding PPL and CPL.</td>
</tr>
<tr>
<td>4.b.3</td>
<td>HUD attitude versus FSTD attitude indicator (pitch and roll of horizon).</td>
<td>Pitch and roll align with aircraft instruments.</td>
<td>Flight.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>For level R: Alignment requirement only applies to the pilot flying. R – excluding PPL and CPL.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
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<td>COMMENTS</td>
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<tr>
<td>4.c</td>
<td>Enhanced Flight Vision System (EFVS)</td>
<td>Alignment between EFVS display and out of the window image should represent the alignment typical of the aircraft and system type.</td>
<td>Take-off point and on approach at 200 ft.</td>
<td>✓</td>
<td>Note.— The effects of the alignment tolerance in 4.b.1 should be taken into account.</td>
<td></td>
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</tr>
<tr>
<td>4.c.1</td>
<td>Registration test.</td>
<td>Alignment between EFVS display and out of the window image should represent the alignment typical of the aircraft and system type.</td>
<td>Take-off point and on approach at 200 ft.</td>
<td>✓</td>
<td>Alignment requirement only applies to the pilot flying.</td>
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<td>Note.— The effects of the alignment tolerance in 4.b.1 should be taken into account.</td>
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<td>R – excluding PPL and CPL.</td>
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<tr>
<td>4.c.2</td>
<td>EFVS RVR and visibility calibration.</td>
<td>The scene represents the EFVS view at 350 m (1200 ft) and 1609 m (1 sm) RVR including correct light intensity.</td>
<td>Flight.</td>
<td>✓</td>
<td>✓</td>
<td>Infra-red scene representative of both 350 m (1200 ft), and 1609 m (1 sm) RVR.</td>
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<td>Visual scene may be removed.</td>
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<td>R – excluding PPL and CPL.</td>
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<tr>
<td>4.c.3</td>
<td>Thermal crossover.</td>
<td>Demonstrate thermal crossover effects during day to night transition.</td>
<td>Day &amp; night.</td>
<td>✓</td>
<td>✓</td>
<td>The scene will correctly represent the thermal characteristics of the scene during a day to night transition.</td>
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<td>R – excluding PPL and CPL.</td>
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<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<tr>
<td>4.d</td>
<td>Visual ground segment</td>
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<tr>
<td>4.d.1</td>
<td>Visual ground segment (VGS).</td>
<td>Near end: the correct number of approach lights within the computed VGS should be visible. Far end: ±20% of the computed VGS. The threshold lights computed to be visible should be visible in the FSTD.</td>
<td>Trimmed in the landing configuration at 30 m (100 ft) wheel height above touchdown zone on glide slope at an RVR setting of 300 m (1 000 ft) or 350 m (1200 ft).</td>
<td>✓</td>
<td>✓</td>
<td>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 aeroplane’s operational envelope for a normal approach and landing; and 4) Radio altimeter. If a generic aeroplane is used as the basic model, a generic cut-off angle of 15˚ is assumed as an ideal. 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.</td>
<td></td>
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<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<td>R1</td>
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<tr>
<td><strong>4.e</strong></td>
<td>Visual System Capacity</td>
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<tr>
<td><strong>4.e.1</strong></td>
<td>System capacity – Day mode.</td>
<td>Not less than: 10 000 visible textured surfaces, 6 000 light points, 16 moving models.</td>
<td>Not applicable.</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>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.</td>
</tr>
<tr>
<td><strong>4.e.2</strong></td>
<td>System capacity – Twilight/night mode.</td>
<td>Not less than: 10 000 visible textured surfaces, 15 000 light points, 16 moving models.</td>
<td>Not applicable.</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>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.</td>
</tr>
<tr>
<td><strong>4.e.3</strong></td>
<td>System capacity – Reduced FOV visual systems.</td>
<td>Not less than: 3 500 visible textured surfaces, 5 000 light points, 16 moving models.</td>
<td>Not applicable.</td>
<td></td>
<td>✔</td>
<td></td>
<td>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. Applies when used to support MPL1 or IR training, both applications allowing the use of a reduced FOV visual system.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<td>5</td>
<td>SOUND SYSTEMS</td>
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<td>Sound tests with a fidelity level of R have been divided into three sub-categories:</td>
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<td>RA - which covers:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(T): MPL4, Re; and</td>
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<td></td>
<td>(TP): MPL4, TR, ATP, RO, IO, CQ, RL.</td>
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<td>RB - which covers:</td>
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<td>(T): MPL3, TR, IO, RO, RL; and</td>
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<td>(TP): MPL3.</td>
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<td>and</td>
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<td>RC - which covers:</td>
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<td>(T): MPL2; and</td>
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<td>(TP): MPL2.</td>
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<td>The following table will refer to RA, RB and RC for convenience.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<td>R1</td>
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<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>5.a</td>
<td></td>
<td>Turbo-jet/Turbo-fan aeroplanes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>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 bands 17 to 42 (50 Hz to 16 kHz).</td>
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<td>A measurement of minimum 20 s should be taken at the location corresponding to the approved data set.</td>
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<td>The approved data set and FSTD results should be produced using comparable data analysis techniques.</td>
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<td>Refer to paragraph 3.7 of Part II, Appendix B.</td>
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<td>For level RC, tests in this section may be presented as a single overall SPL level.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
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</tr>
<tr>
<td>5.a</td>
<td>(1) Ready for engine start.</td>
<td>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. 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.</td>
<td>Ground.</td>
<td>✓</td>
<td>RA</td>
<td></td>
<td>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 ± 5 dB tolerance but not more than 2 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.</td>
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</tbody>
</table>
### Part III. Flight Simulation Feature and Fidelity Level Criteria

### Appendix B. Validation tests for feature fidelity levels

#### III-App B-6

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.a</td>
<td>(1) Ready for engine start. (ctd)</td>
<td>Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
<td></td>
<td></td>
<td>✓</td>
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<td></td>
<td></td>
<td>RC</td>
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</tr>
<tr>
<td>5.a</td>
<td>(2) All engines at idle.</td>
<td>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.</td>
<td>Ground.</td>
<td></td>
<td>✓</td>
<td>RA</td>
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</table>

Normal condition prior to take-off.

For level RA: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 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.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.a</td>
<td>(2) All engines at idle (ctd)</td>
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<tr>
<td></td>
<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<tr>
<td></td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td></td>
<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<tr>
<td></td>
<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>RC</td>
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<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<tr>
<td>5.a</td>
<td>(3) All engines at maximum allowable thrust with brakes set.</td>
<td>Initial evaluation: ± 5 dB per 1/3 octave band.</td>
<td>Ground.</td>
<td></td>
<td>✓</td>
<td>RA</td>
<td>Normal condition prior to take-off. This test is intended to check the maximum stabilized allowable thrust with brakes set, without jeopardizing the aircraft and safety. For level RA: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 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.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>RB</td>
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<td></td>
<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td>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.</td>
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<td>TEST</td>
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<tr>
<td>5.a</td>
<td>(3) All engines at maximum allowable thrust with brakes set. (ctd)</td>
<td>Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
<td></td>
<td></td>
<td>✓</td>
<td>RC</td>
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<tr>
<td>5.a</td>
<td>(4) Climb.</td>
<td>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.</td>
<td>En-route climb.</td>
<td></td>
<td>✓</td>
<td>RA</td>
<td>Medium altitude. For level RA: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 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.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
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<tr>
<td>5.a</td>
<td>(4) Climb. (ctd)</td>
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<td></td>
<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td>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.</td>
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<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>✓</td>
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<td>RB</td>
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<td>RC</td>
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<td>Initial evaluation: ± 5 dB per 1/3 octave band.</td>
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<td>For level RA: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct.</td>
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<td>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.</td>
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<td>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.</td>
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<tr>
<td></td>
<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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### TEST TOLERANCE

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<tbody>
<tr>
<td>5.a</td>
<td>(5) Cruise. (ctd)</td>
<td>Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
<td></td>
<td></td>
<td>✓</td>
<td>RC</td>
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<tr>
<td>5.a</td>
<td>(6) Speed brake/spoilers extended (as appropriate).</td>
<td>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.</td>
<td></td>
<td>✓</td>
<td>RA</td>
<td></td>
<td>Normal and constant speed brake deflection for descent at a constant airspeed and power setting. For level RA: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 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...</td>
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</tr>
<tr>
<td>5.a (6)</td>
<td>Speed brake/spoilers extended (as appropriate). (ctd)</td>
<td>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.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>RB</td>
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<tr>
<td></td>
<td></td>
<td>Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>5.a</td>
<td>(7) Initial approach.</td>
<td>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.</td>
<td>Approach.</td>
<td>✓</td>
<td>RA</td>
<td>Constant airspeed, gear up, flaps/slats as appropriate. For level RA: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 that are consecutive and in any case within ± 7 dB from approved reference data, providing that the overall trend is correct. For level RB: where initial evaluation employs approved subjective tuning to develop the approved reference standard, recurrent evaluation tolerances should be used during recurrent evaluations.</td>
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<td>5.a</td>
<td>(7) Initial approach. (ctd)</td>
<td>Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
<td></td>
<td></td>
<td>✓</td>
<td>RC</td>
<td></td>
</tr>
<tr>
<td>5.a</td>
<td>(8) Final approach.</td>
<td>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.</td>
<td>Landing.</td>
<td></td>
<td>✓</td>
<td>RA</td>
<td>Constant airspeed, gear down, landing configuration flaps. For level RA: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 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</td>
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<td>5.a</td>
<td>(8) Final approach. (ctd)</td>
<td>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.</td>
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<td></td>
<td>√</td>
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<tr>
<td>5.b</td>
<td>Propeller-driven aeroplanes</td>
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</tbody>
</table>

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).

A measurement of minimum 20 s should be taken 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 Part II, Appendix B.

For level RC, tests in this section may be presented as a single overall SPL level.
<table>
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<tbody>
<tr>
<td>5.b</td>
<td>(1) Ready for engine start.</td>
<td>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.</td>
<td>Ground.</td>
<td>✓</td>
<td>RA</td>
<td></td>
<td>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 ±5 dB tolerance but not more than 2 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.</td>
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<td></td>
<td></td>
<td>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.</td>
<td></td>
<td>✓</td>
<td>RB</td>
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<tr>
<td>5.b</td>
<td>(1) Ready for engine start. (ctd)</td>
<td>Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>RC</td>
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<tr>
<td>5.b</td>
<td>(2) All propellers feathered, if applicable.</td>
<td>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.</td>
<td>Ground.</td>
<td>✓</td>
<td></td>
<td></td>
<td>Normal condition prior to take-off. For level RA: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 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.</td>
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<td>5.b</td>
<td>(2) All propellers feathered, if applicable. (ctd)</td>
<td>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.</td>
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<td>✓</td>
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</table>
| 5.b  | (3) Ground idle or equivalent. | 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 take-off. |
|      |           | 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 | | For level RA: it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 that are consecutive and in any case within ±7 dB from approved reference data, providing that the overall trend is correct. |
<p>|      |           | | | | | | 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. |</p>
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<tbody>
<tr>
<td>5.b (3)</td>
<td>Ground idle or equivalent. (cont.)</td>
<td>Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>RC</td>
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<tr>
<td>5.b (4)</td>
<td>Flight idle or equivalent.</td>
<td>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.</td>
<td>Ground.</td>
<td>✓</td>
<td>RA</td>
<td>Normal condition prior to take-off. For level RA: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 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.</td>
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<tr>
<td>5.b</td>
<td>Flight idle or equivalent. (ctd)</td>
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<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
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<td>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.</td>
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<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td></td>
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<td>✓</td>
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<td>RB</td>
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<tbody>
<tr>
<td>5.b</td>
<td>All engines at maximum allowable power with brakes set.</td>
<td>Ground.</td>
<td></td>
<td>✓</td>
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<td>Normal condition prior to take-off.</td>
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<td>RA</td>
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<td>✓</td>
<td>RB</td>
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</table>

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.

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.

For level RA:

it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 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.
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<tr>
<td>5.b (5)</td>
<td>All engines at maximum allowable power with brakes set. (ctd)</td>
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<td></td>
<td>Initial evaluation: subjective assessment of measured overall SPL.</td>
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<td></td>
<td>Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
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<td>5.b (6)</td>
<td>Climb.</td>
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<td>Medium altitude.</td>
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<td>Initial evaluation: ±5 dB per 1/3 octave band.</td>
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<td>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.</td>
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<tr>
<td></td>
<td>En-route climb.</td>
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<td>✓</td>
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For level RA:
- it would be acceptable to have some 1/3 octave bands out of ±5 dB tolerance but not more than 2 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.
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<td>RC</td>
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<tr>
<td>TEST</td>
<td>FLIGHT CONDITION</td>
<td>TOLERANCE</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>------</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>For level RA: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Initial evaluation: subjective assessment of 1/3 octave bands.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
<td></td>
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</tr>
</tbody>
</table>
## Part III. Flight Simulation Feature and Fidelity Level Criteria

### Appendix B. Validation tests for feature fidelity levels

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>
| 5.b (7) Cruise. (ctd) | Initial evaluation: subjective assessment of measured overall SPL. 
Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation. | Approach. | | | ✓ | | |
| 5.b (8) Initial 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. | Approach. | | | ✓ | RA | Constant airspeed, gear up, flaps extended as appropriate, RPM as per operating manual. 
For level RA: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 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. |
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.b</td>
<td>(8) Initial approach. (ctd)</td>
<td>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.</td>
<td></td>
<td>✓</td>
<td>R</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
<td></td>
<td>✓</td>
<td>R</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>
## Part III. Flight Simulation Feature and Fidelity Level Criteria

### Appendix B. Validation tests for feature fidelity levels

<table>
<thead>
<tr>
<th>TEST</th>
<th>FLIGHT CONDITION</th>
<th>TOLERANCE</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.b</td>
<td>Final approach.</td>
<td>Landing.</td>
<td></td>
<td></td>
<td>✓</td>
<td>RA</td>
<td>Constant airspeed, gear down, landing configuration flaps, RPM as per operating manual. For level RA: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 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.</td>
</tr>
</tbody>
</table>

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.

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.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.b</td>
<td>(9) Final approach. (ctd)</td>
<td>Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>RC</td>
</tr>
</tbody>
</table>
### TEST TOLERANCE

<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.c</td>
<td>Special cases</td>
<td>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.</td>
<td>✓</td>
<td>RA</td>
<td></td>
<td></td>
<td>This applies to special steady-state cases identified as particularly significant to the pilot, important in training, or unique to a specific aeroplane type or model. For level RA: it would be acceptable to have some 1/3 octave bands out of ± 5 dB tolerance but not more than 2 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. 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). A measurement of minimum 20 s should be taken 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 Part II, Appendix B.</td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>------</td>
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<td>---</td>
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<td>----------</td>
</tr>
<tr>
<td>5.c (ctd)</td>
<td>Special cases (ctd)</td>
<td>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.</td>
<td></td>
<td></td>
<td>✓</td>
<td>RB</td>
<td>For level RC, tests in this section may be presented as a single overall SPL level.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Initial evaluation: subjective assessment of measured overall SPL. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEST</td>
<td>TOLERANCE</td>
<td>FLIGHT CONDITION</td>
<td>G</td>
<td>R1</td>
<td>R</td>
<td>S</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>------</td>
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<td>---</td>
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<td>----------</td>
</tr>
<tr>
<td>5.d</td>
<td>FSTD background noise</td>
<td>Initial evaluation: background noise levels should fall below the plot in Figure B-10 of Part II, Appendix B. Recurrent evaluation: ±3 dB per 1/3 octave band compared to initial evaluation.</td>
<td>✓</td>
<td>RA</td>
<td>RB</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

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 Part II, Appendix B.

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 bands 17 to 42 (50 Hz to 16 kHz).

For level RC, this test may be presented as a single overall SPL level.
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>
| 5.e  | 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
|      |           | Initial evaluation: not applicable. Recurrent evaluation: ±3 dB SPL RMS compared to initial evaluation. | | | ✓ | | RB
|      |           | | | | ✓ | | RC

Only required if the results are to be used during recurrent evaluations according to paragraph 3.7.8 of Part II, Appendix B.

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 bands 17 to 42 (50 Hz to 16 kHz).

For level RC, this test should be run at three frequencies (high, mid-range, and low).
<table>
<thead>
<tr>
<th>TEST</th>
<th>TOLERANCE</th>
<th>FLIGHT CONDITION</th>
<th>G</th>
<th>R1</th>
<th>R</th>
<th>S</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>SYSTEMS INTEGRATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.a</td>
<td>System response time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1) Transport delay.</td>
<td>100 milliseconds (ms) or less after controller movement.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 milliseconds or less after controller movement.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pitch, roll and yaw.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓ ✓ ✓ ✓ One separate test is required in each axis. Where EFVS systems are installed, the EFVS response should be within + or – 30 ms from visual system response, and not before motion system response. Note.— The delay from aeroplane EFVS electronic elements should be added to the 30 ms tolerance before comparison with visual system reference as described in Attachment G of Part II.</td>
<td></td>
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</tbody>
</table>
Appendix C

FUNCTIONS AND SUBJECTIVE TESTS

1. INTRODUCTION

1.1 Accurate replication of aeroplane systems functions should be checked at each flight crew member position. This includes procedures using the AFM and checklists. Handling qualities, performance and FSTD systems operation will 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 aeroplane. Unlike the objective tests listed in Appendix B, 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 or special emphasis items in the training programme. Unless directly related to a requirement for the current qualification level, 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. A useful source of guidance for conducting the functions and subjective tests is published in the RAeS Aeroplane Flight Simulator Evaluation Handbook, Volume II (see Chapter 2 of this Part, paragraph 2.3).

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

2.3 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 aeroplane related procedures, normally contained in a Quick Reference Handbook (QRH). Systems are listed separately under "any flight phase" to ensure appropriate attention to systems checks.
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 VII.

Note 2. — The special needs for a more sophisticated Air Traffic Control (ATC) environment simulation system in accordance with Appendix A of this Part, paragraph 9 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 aeroplane and as applicable to the FSTD type.

<table>
<thead>
<tr>
<th>Number</th>
<th>Functions and Subjective Tests</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Preparation for flight</td>
<td></td>
</tr>
<tr>
<td>1.a</td>
<td>Pre-flight. Accomplish a functions check of all switches, indicators, systems, and equipment at all crew members’ and instructors’ stations and determine that:</td>
<td></td>
</tr>
<tr>
<td>1.a.1</td>
<td>The flight deck design and functions are identical to that of the aeroplane simulated.</td>
<td></td>
</tr>
<tr>
<td>1.a.2</td>
<td>The flight deck design and functions represent those of the simulated class of aeroplanes.</td>
<td></td>
</tr>
<tr>
<td>1.a.3</td>
<td>The flight deck design and functions are aeroplane-like and generic but recognizable as within a class of aeroplanes.</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Applicability</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>2</td>
<td>Surface operations (pre-flight)</td>
<td></td>
</tr>
<tr>
<td>2.a</td>
<td>Engine start</td>
<td></td>
</tr>
<tr>
<td>2.a.1</td>
<td>Normal start</td>
<td></td>
</tr>
<tr>
<td>2.a.2</td>
<td>Alternate start procedures</td>
<td></td>
</tr>
<tr>
<td>2.a.3</td>
<td>Abnormal starts and shutdowns (hot start, hung start, tail pipe fire, etc.)</td>
<td></td>
</tr>
<tr>
<td>2.b</td>
<td>Taxi</td>
<td></td>
</tr>
<tr>
<td>2.b.1</td>
<td>Pushback/powerback</td>
<td></td>
</tr>
<tr>
<td>2.b.2</td>
<td>Thrust response</td>
<td></td>
</tr>
<tr>
<td>2.b.3</td>
<td>Power lever friction</td>
<td></td>
</tr>
<tr>
<td>2.b.4</td>
<td>Ground handling</td>
<td></td>
</tr>
<tr>
<td>2.b.5</td>
<td>Nosewheel scuffing</td>
<td></td>
</tr>
<tr>
<td>2.b.6</td>
<td>Taxi aids (e.g. taxi camera, moving map)</td>
<td></td>
</tr>
<tr>
<td>2.b.7</td>
<td>Low visibility (taxi route, signage, lighting, markings, etc.)</td>
<td></td>
</tr>
<tr>
<td>2.c</td>
<td>Brake operation</td>
<td></td>
</tr>
<tr>
<td>2.c.1</td>
<td>Normal, automatic and alternate/emergency operation</td>
<td></td>
</tr>
<tr>
<td>2.c.2</td>
<td>Brake fade</td>
<td></td>
</tr>
<tr>
<td>2.d</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Applicability</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>3</td>
<td>Take-off</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Note.— Only those take-off tests relevant to the simulated aeroplane type or class should be selected from the following list, where tests should be made with limiting wind velocities, wind shear and with relevant system failures.</td>
<td></td>
</tr>
<tr>
<td>3.a</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>3.a.1</td>
<td>Aeroplane/engine parameter relationships, including run-up</td>
<td></td>
</tr>
<tr>
<td>3.a.2</td>
<td>Nosewheel and rudder steering</td>
<td></td>
</tr>
<tr>
<td>3.a.3</td>
<td>Crosswind (maximum demonstrated)</td>
<td></td>
</tr>
<tr>
<td>3.a.4</td>
<td>Special performance:</td>
<td></td>
</tr>
<tr>
<td>3.a.4.a</td>
<td>Reduced $V_1$</td>
<td></td>
</tr>
<tr>
<td>3.a.4.b</td>
<td>Maximum engine de-rate</td>
<td></td>
</tr>
<tr>
<td>3.a.4.c</td>
<td>Soft surface</td>
<td></td>
</tr>
<tr>
<td>3.a.4.d</td>
<td>Short field/short take-off and landing (STOL) operations</td>
<td></td>
</tr>
<tr>
<td>3.a.4.e</td>
<td>Obstacle (performance over visual obstacle)</td>
<td></td>
</tr>
<tr>
<td>3.a.5</td>
<td>Low visibility take-off</td>
<td></td>
</tr>
<tr>
<td>3.a.6</td>
<td>Landing gear, wing flap and leading edge device operation</td>
<td></td>
</tr>
<tr>
<td>3.a.7</td>
<td>Contaminated runway operations</td>
<td></td>
</tr>
<tr>
<td>3.a.8</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Applicability</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>3.b</td>
<td>Abnormal/emergency</td>
<td></td>
</tr>
<tr>
<td>3.b.1</td>
<td>Rejected take-off</td>
<td></td>
</tr>
<tr>
<td>3.b.2</td>
<td>Rejected special performance take-off (e.g. reduced V1, maximum engine de-rate, soft field, short field/short take-off and landing (STOL) operations, etc.)</td>
<td></td>
</tr>
<tr>
<td>3.b.3</td>
<td>Rejected take-off with contaminated runway</td>
<td></td>
</tr>
<tr>
<td>3.b.4</td>
<td>Continued take-off with failure of most critical engine at most critical point</td>
<td></td>
</tr>
<tr>
<td>3.b.5</td>
<td>Flight control system failures, reconfiguration modes, manual reversion and associated handling</td>
<td></td>
</tr>
<tr>
<td>3.b.6</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Climb</td>
<td></td>
</tr>
<tr>
<td>4.a</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>4.b</td>
<td>One or more engine(s) inoperative</td>
<td></td>
</tr>
<tr>
<td>4.c</td>
<td>Approach climb in icing (for aeroplanes with icing accountability)</td>
<td></td>
</tr>
<tr>
<td>4.d</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Cruise</td>
<td></td>
</tr>
<tr>
<td>5.a</td>
<td>Performance characteristics (speed versus power, configuration, and attitude)</td>
<td></td>
</tr>
<tr>
<td>5.a.1</td>
<td>Straight and level flight</td>
<td></td>
</tr>
<tr>
<td>5.a.2</td>
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<td>5.b.14</td>
<td>Visual resolution and FSTD handling and performance for the following:</td>
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<td>6.c</td>
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<tr>
<td>6.d</td>
<td>Flight control system failures, reconfiguration modes, manual reversion and associated handling</td>
<td></td>
</tr>
<tr>
<td>6.e</td>
<td>Other</td>
<td></td>
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</tbody>
</table>
### Part III. Flight Simulation Feature and Fidelity Level Criteria

#### Appendix C. Functions and subjective tests

<table>
<thead>
<tr>
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<th>Functions and Subjective Tests</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Instrument approaches and landing</td>
<td></td>
</tr>
</tbody>
</table>

Note.— Only those instrument approach and landing tests relevant to the simulated aeroplane type or class should be selected from the following list, where tests should be made with limiting wind velocities, wind shear (except for the CAT II and III precision approaches) and with relevant system failures.

#### 7.a  
**Precision approach**

<table>
<thead>
<tr>
<th>7.a.1</th>
<th>CAT I published approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.a.1.a</td>
<td>Manual approach with/without flight director including landing</td>
</tr>
<tr>
<td>7.a.1.b</td>
<td>Autopilot/autothrottle coupled approach and manual landing</td>
</tr>
<tr>
<td>7.a.1.c</td>
<td>Autopilot/autothrottle coupled approach, engine(s) inoperative</td>
</tr>
<tr>
<td>7.a.1.d</td>
<td>Manual approach, engine(s) inoperative</td>
</tr>
<tr>
<td>7.a.1.e</td>
<td>HUD/EFVS</td>
</tr>
<tr>
<td>7.a.2</td>
<td>CAT II published approaches</td>
</tr>
<tr>
<td>7.a.2.a</td>
<td>Autopilot/autothrottle coupled approach to DH and landing (manual and autoland)</td>
</tr>
<tr>
<td>7.a.2.b</td>
<td>Autopilot/autothrottle coupled approach with one-engine-inoperative approach to DH and go-around (manual and autopilot)</td>
</tr>
<tr>
<td>7.a.2.c</td>
<td>HUD/EFVS</td>
</tr>
<tr>
<td>7.a.3</td>
<td>CAT III published approaches</td>
</tr>
<tr>
<td>7.a.3.a</td>
<td>Autopilot/autothrottle coupled approach to landing and roll-out (if applicable) guidance (manual and autoland)</td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>7.a.3.b</td>
<td>Autopilot/autothrottle coupled approach to DH and go-around (manual and autopilot)</td>
</tr>
<tr>
<td>7.a.3.c</td>
<td>Autopilot/autothrottle coupled approach to land and roll-out (if applicable) guidance with one engine inoperative (manual and autoland)</td>
</tr>
<tr>
<td>7.a.3.d</td>
<td>Autopilot/autothrottle coupled approach to DH and go-around with one engine inoperative (manual and autopilot)</td>
</tr>
<tr>
<td>7.a.3.e</td>
<td>HUD/EFVS</td>
</tr>
<tr>
<td>7.a.4</td>
<td>Autopilot/autothrottle coupled approach (to a landing or to a go-around):</td>
</tr>
<tr>
<td>7.a.4.a</td>
<td>With generator failure</td>
</tr>
<tr>
<td>7.a.4.b</td>
<td>With maximum tail wind component certified or authorized</td>
</tr>
<tr>
<td>7.a.4.c</td>
<td>With maximum crosswind component demonstrated or authorized</td>
</tr>
<tr>
<td>7.a.5</td>
<td>PAR approach, all engine(s) operating and with one or more engine(s) inoperative</td>
</tr>
<tr>
<td>7.a.6</td>
<td>MLS, GBAS, all engine(s) operating and with one or more engine(s) inoperative</td>
</tr>
<tr>
<td>7.b</td>
<td>Non-precision approach</td>
</tr>
<tr>
<td>7.b.1</td>
<td>Surveillance radar approach, all engine(s) operating and with one or more engine(s) inoperative</td>
</tr>
<tr>
<td>7.b.2</td>
<td>NDB approach, all engine(s) operating and with one or more engine(s) inoperative</td>
</tr>
<tr>
<td>7.b.3</td>
<td>VOR, VOR/DME, TACAN approach, all engines(s) operating and with one or more engine(s) inoperative</td>
</tr>
<tr>
<td>Number</td>
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<tr>
<td>7.b.4</td>
<td>RNAV/RNP/GNSS (RNP at nominal and minimum authorized temperatures) approach, all engine(s) operating and with one or more engine(s) inoperative</td>
</tr>
<tr>
<td>7.b.5</td>
<td>ILS LLZ (LOC), LLZ back course (or LOC-BC) approach, all engine(s) operating and with one or more engine(s) inoperative</td>
</tr>
<tr>
<td>7.b.6</td>
<td>ILS offset localizer approach, all engine(s) operating and with one or more engine(s) inoperative</td>
</tr>
<tr>
<td>7.c</td>
<td>Approach procedures with vertical guidance (APV), e.g. SBAS, flight path vector</td>
</tr>
<tr>
<td>7.c.1</td>
<td>APV/baro-VNAV approach, all engine(s) operating and with one or more engine(s) inoperative</td>
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<td>7.c.2</td>
<td>Area navigation (RNAV) approach procedures based on SBAS, all engine(s) operating and with one or more engine(s) inoperative</td>
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<td>Visual approaches (segment) and landings</td>
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<td>8.b</td>
<td>Approach and landing with one or more engine(s) inoperative</td>
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<td>8.c</td>
<td>Operation of landing gear, flap/slats and speedbrakes (normal and abnormal)</td>
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<td>8.d</td>
<td>Approach and landing with crosswind (maximum demonstrated crosswind component)</td>
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<td>8.e</td>
<td>Approach and landing with flight control system failures (for reconfiguration modes, manual reversion and associated handling with the most significant degradation which is probable)</td>
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<td>8.f</td>
<td>Approach and landing with standby (minimum) electrical/hydraulic power</td>
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<td>Number</td>
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<tr>
<td>8.g</td>
<td>Approach and landing from circling conditions (circling approach)</td>
</tr>
<tr>
<td></td>
<td><em>Note.</em>— Requires as a minimum a representative airport scene that can provide a heading difference of 90°, or more, and 180°, or less, between approach and landing runways. Any associated hazard lights or any other visual aids for use as part of the published circling procedure should be included in the correct position(s) and be of the appropriate colour(s), directionality and behaviour. However, where the requirement for the visual system fidelity level is G, a generic airport model to be consistent with published data used for aeroplane operations should contain both the approach and landing runways and have the capability to light both at the same time. Any associated hazard lights or any other visual aids for use as part of the published circling procedure need to be included in the correct position(s) and be of the appropriate colour(s) and behaviour.</td>
</tr>
<tr>
<td>8.h</td>
<td>Approach and landing from a visual traffic pattern</td>
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<td>8.i</td>
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<td>8.k</td>
<td>Other</td>
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<tr>
<td></td>
<td><em>Note.</em>— An FSTD with a visual system, which permits completing a special approach procedure in accordance with applicable regulations, may be approved for that particular approach procedure.</td>
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<td><strong>Missed Approach</strong></td>
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<td>Reduction of rudder effectiveness with increased reverse thrust (rear pod-mounted engines)</td>
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<td>10.a.6</td>
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<tr>
<td>10.a.6.a</td>
<td>Brake and anti-skid operation with dry, wet, icy, patchy wet, patchy ice, wet on rubber residue in touchdown zone conditions</td>
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<tr>
<td>10.a.6.b</td>
<td>Brake and anti-skid operation with dry and wet conditions</td>
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<td>Autopilot and flight director</td>
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<td>11.a.16</td>
<td>Terrain awareness warning systems and collision avoidance systems (e.g. EGPWS, GPWS, TCAS)</td>
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<td>11.a.17</td>
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<td>Flight management systems</td>
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<td>Head-up displays (including EFVS, if appropriate)</td>
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<td>11.a.21</td>
<td>Navigation systems</td>
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<td>11.a.22</td>
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<td>11.a.28</td>
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<td>11.b</td>
<td><strong>Airborne procedures</strong></td>
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<td>11.b.1</td>
<td>Holding</td>
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<td>11.b.2</td>
<td>Air hazard avoidance (traffic, weather, including visual correlation)</td>
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<td>Wind shear:</td>
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<td>11.b.3.a</td>
<td>Prior to take-off rotation</td>
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<td>11.b.3.c</td>
<td>During initial climb</td>
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<td>11.b.3.d</td>
<td>On final approach, below 150 m (500 ft) AGL.</td>
</tr>
</tbody>
</table>

12 Visual System

This section is written in the context of the operator presenting models of real-world airports, serviced by the aeroplane type being simulated, for use in completion of the functions and subjective tests described in this appendix. The models should also be airports that are used regularly in the training programme(s) and, as applicable, may be presented for approval of circling approaches. However, where the requirement for the device visual system fidelity level 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).

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 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.

12.a.1 Airport scenes

12.a.1.a A minimum of three (3) real-world airport models to be consistent with published data used for aeroplane operations and capable of demonstrating all the visual system features below. Each model should be in a different visual scene to permit assessment of FSTD automatic visual scene changes. Each model should be selectable from the IOS.

12.a.1.b A minimum of one (1) real-world airport model to be consistent with published data used for aeroplane operations. This model should be acceptable to the operator’s NAA and selectable from the IOS.

12.a.1.c A minimum of one (1) generic airport model to be consistent with published data used for aeroplane operations. This model should be acceptable to the operator’s NAA and selectable from the IOS.
<table>
<thead>
<tr>
<th>Number</th>
<th>Functions and Subjective Tests</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.a.2</td>
<td>Visual scene fidelity</td>
<td></td>
</tr>
<tr>
<td>12.a.2.a</td>
<td>The visual scene should correctly represent the parts of the airport and its surroundings used in the training program.</td>
<td></td>
</tr>
<tr>
<td>12.a.2.b</td>
<td>The fidelity of the visual scene should be sufficient for the aircrew to visually identify the airport; determine the position of the simulated aeroplane; successfully accomplish take-offs, approaches, and landings; and manoeuvre around the airport on the ground as necessary.</td>
<td></td>
</tr>
<tr>
<td>12.a.2.c</td>
<td>The fidelity of the visual scene should be sufficient for the aircrew to successfully accomplish take-offs, approaches, and landings.</td>
<td></td>
</tr>
<tr>
<td>12.a.3</td>
<td>Runways and taxiways</td>
<td></td>
</tr>
<tr>
<td>12.a.3.a</td>
<td>The airport runways and taxiways</td>
<td></td>
</tr>
<tr>
<td>12.a.3.b</td>
<td>Representative runways and taxiways</td>
<td></td>
</tr>
<tr>
<td>12.a.3.c</td>
<td>Generic runways and taxiways</td>
<td></td>
</tr>
<tr>
<td>12.a.4</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>12.a.5</td>
<td>Runway threshold elevations and locations should be modelled to provide correlation with aeroplane systems (e.g. HUD, GPS, compass, altimeter).</td>
<td></td>
</tr>
<tr>
<td>12.a.6</td>
<td>Slopes in runways, taxiways, and ramp areas should not cause distracting or unrealistic effects, including pilot eye-point height variation.</td>
<td></td>
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<tr>
<td>12.a.7</td>
<td>Runway surface and markings for each “in-use” runway should include the following, if appropriate:</td>
<td></td>
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<tr>
<td>12.a.7.a</td>
<td>Threshold markings</td>
<td></td>
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<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Applicability</td>
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<tr>
<td>12.a.7.b</td>
<td>Runway numbers</td>
<td></td>
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<tr>
<td>12.a.7.c</td>
<td>Touchdown zone markings</td>
<td></td>
</tr>
<tr>
<td>12.a.7.d</td>
<td>Fixed distance markings</td>
<td></td>
</tr>
<tr>
<td>12.a.7.e</td>
<td>Edge markings</td>
<td></td>
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<tr>
<td>12.a.7.f</td>
<td>Centre line markings</td>
<td></td>
</tr>
<tr>
<td>12.a.7.g</td>
<td>Distance remaining signs</td>
<td></td>
</tr>
<tr>
<td>12.a.7.h</td>
<td>Signs at intersecting runways and taxiways</td>
<td></td>
</tr>
<tr>
<td>12.a.7.i</td>
<td>Windsock that gives appropriate wind cues</td>
<td></td>
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<tr>
<td>12.a.8</td>
<td>Runway lighting of appropriate colours, directionality, behaviour and spacing for the “in-use” runway including the following:</td>
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<tr>
<td>12.a.8.a</td>
<td>Threshold lights</td>
<td></td>
</tr>
<tr>
<td>12.a.8.b</td>
<td>Edge lights</td>
<td></td>
</tr>
<tr>
<td>12.a.8.c</td>
<td>End lights</td>
<td></td>
</tr>
<tr>
<td>12.a.8.d</td>
<td>Centre line lights</td>
<td></td>
</tr>
<tr>
<td>12.a.8.e</td>
<td>Touchdown zone lights</td>
<td></td>
</tr>
<tr>
<td>12.a.8.f</td>
<td>Lead-off lights</td>
<td></td>
</tr>
<tr>
<td>12.a.8.g</td>
<td>Appropriate visual landing aid(s) for that runway</td>
<td></td>
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<tr>
<td>12.a.8.h</td>
<td>Appropriate approach lighting system for that runway</td>
<td></td>
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<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Applicability</td>
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<tr>
<td>12.a.9</td>
<td>Taxiway surface and markings (associated with each “in-use” runway):</td>
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</tr>
<tr>
<td>12.a.9.a</td>
<td>Edge markings</td>
<td></td>
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<tr>
<td>12.a.9.b</td>
<td>Centre line markings</td>
<td></td>
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<tr>
<td>12.a.9.c</td>
<td>Runway holding position markings</td>
<td></td>
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<tr>
<td>12.a.9.d</td>
<td>ILS critical area markings</td>
<td></td>
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<tr>
<td>12.a.9.e</td>
<td>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.</td>
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<tr>
<td>12.a.10</td>
<td>Taxiway lighting of appropriate colours, directionality, behaviour and spacing (associated with each “in-use” runway):</td>
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<tr>
<td>12.a.10.a</td>
<td>Edge lights</td>
<td></td>
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<tr>
<td>12.a.10.b</td>
<td>Centre line lights</td>
<td></td>
</tr>
<tr>
<td>12.a.10.c</td>
<td>Runway holding position and ILS critical area lights</td>
<td></td>
</tr>
<tr>
<td>12.a.11</td>
<td>Required visual model correlation with other aspects of the airport environment simulation.</td>
<td></td>
</tr>
<tr>
<td>12.a.11.a</td>
<td>The airport model should be properly aligned with the navigational aids that are associated with operations at the runway “in-use”.</td>
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<tr>
<td>12.a.11.b</td>
<td>The simulation of runway contaminants should be correlated with the displayed runway surface and lighting.</td>
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<tr>
<td>Number</td>
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<tr>
<td>12.a.12</td>
<td>Airport buildings, structures and lighting</td>
<td></td>
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<tr>
<td>12.a.12.a</td>
<td>Buildings, structures and lighting:</td>
<td></td>
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<tr>
<td>12.a.12.a.1</td>
<td>The airport buildings, structures and lighting</td>
<td></td>
</tr>
<tr>
<td>12.a.12.a.2</td>
<td>Representative airport buildings, structures and lighting</td>
<td></td>
</tr>
<tr>
<td>12.a.12.a.3</td>
<td>Generic airport buildings, structures and lighting</td>
<td></td>
</tr>
<tr>
<td>12.a.12.b</td>
<td>At least one useable gate, set at the appropriate height (required only for those aeroplanes that typically operate from terminal gates)</td>
<td></td>
</tr>
<tr>
<td>12.a.12.c</td>
<td>Representative moving and static gate clutter (e.g. other aeroplanes, power carts, tugs, fuel trucks, additional gates)</td>
<td></td>
</tr>
<tr>
<td>12.a.12.d</td>
<td>Gate/apron markings (e.g. hazard markings, lead-in lines, gate numbering), lighting and gate docking aids or a marshaller</td>
<td></td>
</tr>
<tr>
<td>12.a.13</td>
<td>Terrain and obstacles</td>
<td></td>
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<tr>
<td>12.a.13.a</td>
<td>Terrain and obstacles within 46 km (25 NM) of the reference airport</td>
<td></td>
</tr>
<tr>
<td>12.a.13.b</td>
<td>Representative depiction of terrain and obstacles within 46 km (25 NM) of the reference airport</td>
<td></td>
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<tr>
<td>Number</td>
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<td>Applicability</td>
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</tr>
<tr>
<td>12.a.14</td>
<td>Significant, identifiable natural and cultural features</td>
<td></td>
</tr>
<tr>
<td>12.a.14.a</td>
<td>Significant, identifiable natural and cultural features within 46 km (25 NM) of the reference airport</td>
<td>Note.— This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only provide a reasonable facsimile of runway orientation.</td>
</tr>
<tr>
<td>12.a.14.b</td>
<td>Representative depiction of significant and identifiable natural and cultural features within 46 km (25 NM) of the reference airport</td>
<td>Note. — This refers to natural and cultural features that are typically used for pilot orientation in flight. Outlying airports not intended for landing need only provide a reasonable facsimile of runway orientation.</td>
</tr>
<tr>
<td>12.a.14.c</td>
<td>Representative moving airborne traffic (including the capability to present air hazards — e.g. airborne traffic on a possible collision course)</td>
<td></td>
</tr>
<tr>
<td>12.b</td>
<td>Visual scene management</td>
<td></td>
</tr>
<tr>
<td>12.b.1</td>
<td>All airport runway, approach and taxiway lighting and cultural 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.</td>
<td></td>
</tr>
<tr>
<td>12.b.2</td>
<td>Airport runway, approach and taxiway lighting and cultural 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.</td>
<td></td>
</tr>
<tr>
<td>12.b.3</td>
<td>The directionality of strobe lights, approach lights, runway edge lights, visual landing aids, runway centre line lights, threshold lights, and touchdown zone lights on the runway of intended landing should be realistically replicated.</td>
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<tr>
<td>Number</td>
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</tr>
<tr>
<td>12.c</td>
<td><strong>Visual feature recognition</strong></td>
<td></td>
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<td></td>
<td><em>Note.</em> The following are the minimum distances at which runway features should be visible. Distances are measured from runway threshold to an aeroplane aligned with the runway on an extended 3-degree glide slope in suitable simulated meteorological conditions. For circling approaches, all tests below apply both to the runway used for the initial approach and to the runway of intended landing.</td>
<td></td>
</tr>
<tr>
<td>12.c.1</td>
<td>Runway definition, strobe lights, approach lights, and runway edge white lights from 8 km (5 sm) of the runway threshold</td>
<td></td>
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<tr>
<td>12.c.2</td>
<td><strong>Visual approach aids lights</strong></td>
<td></td>
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<tr>
<td>12.c.2.a</td>
<td>Visual approach aids lights from 8 km (5 sm) of the runway threshold</td>
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</tr>
<tr>
<td>12.c.2.b</td>
<td>Visual approach aids lights from 4.8 km (3 sm) of the runway threshold</td>
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<tr>
<td>12.c.3</td>
<td>Runway centre line lights and taxiway definition from 4.8 km (3 sm)</td>
<td></td>
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<tr>
<td>12.c.4</td>
<td>Threshold lights and touchdown zone lights from 3.2 km (2 sm)</td>
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<tr>
<td>12.c.5</td>
<td>Runway markings within range of landing lights for night scenes; as required by the surface resolution test on day scenes</td>
<td></td>
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<tr>
<td>12.c.6</td>
<td>For circling approaches, the runway of intended landing and associated lighting should fade into view in a non-distracting manner.</td>
<td></td>
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<tr>
<td>12.d</td>
<td><strong>Selectable airport visual scene capability for:</strong></td>
<td></td>
</tr>
<tr>
<td>12.d.1</td>
<td>Night</td>
<td></td>
</tr>
<tr>
<td>12.d.2</td>
<td>Twilight</td>
<td></td>
</tr>
<tr>
<td>12.d.3</td>
<td>Day</td>
<td></td>
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<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Applicability</td>
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<tr>
<td>12.d.4</td>
<td>Dynamic effects — the capability to present multiple ground and air hazards such as another aeroplane crossing the active runway or converging airborne traffic; hazards should be selectable via controls at the instructor station.</td>
<td></td>
</tr>
</tbody>
</table>
| 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.* |               |
<p>| 12.e   | <strong>Correlation with aeroplane and associated equipment</strong> |               |
| 12.e.1 | Visual cues to relate to actual aeroplane responses |               |
| 12.e.2 | <strong>Visual cues during take-off, approach and landing</strong> |               |
| 12.e.2.a | Visual cues to assess sink rate and depth perception during landings |               |
| 12.e.2.b | Visual cueing sufficient to support changes in approach path by using runway perspective. Changes in visual cues during take-off, approach and landing should not distract the pilot. |               |
| 12.e.3 | Accurate portrayal of environment relating to aeroplane attitudes |               |
| 12.e.4 | The visual scene should correlate with integrated aeroplane systems, where fitted (e.g. terrain, traffic and weather avoidance systems and HUD/EFVS). |               |
| 12.e.5 | The effect of rain removal devices should be provided. |               |</p>
<table>
<thead>
<tr>
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<th>Functions and Subjective Tests</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.f</td>
<td>Scene quality</td>
<td></td>
</tr>
<tr>
<td>12.f.1</td>
<td>Quantization</td>
<td></td>
</tr>
<tr>
<td>12.f.1.a</td>
<td>Surfaces and textural cues should be free from apparent quantization (aliasing).</td>
<td></td>
</tr>
<tr>
<td>12.f.1.b</td>
<td>Surfaces and textural cues should not create distracting quantization (aliasing).</td>
<td></td>
</tr>
<tr>
<td>12.f.2</td>
<td>System capable of portraying full colour realistic textural cues.</td>
<td></td>
</tr>
<tr>
<td>12.f.3</td>
<td>The system light points should be free from distracting jitter, smearing or streaking.</td>
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<tr>
<td>12.f.4</td>
<td>System capable of providing focus effects that simulate rain.</td>
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<tr>
<td>12.f.5</td>
<td>System capable of providing light point perspective growth.</td>
<td></td>
</tr>
<tr>
<td>12.g</td>
<td>Environmental effects</td>
<td></td>
</tr>
<tr>
<td>12.g.1</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>12.g.2</td>
<td>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 surface and within a radius of 16 km (10 sm) from the airport.</td>
<td></td>
</tr>
<tr>
<td>12.g.3</td>
<td>One airport with a snow scene, if appropriate to the operator’s area of operations, to include terrain snow and snow-covered taxiways and runways.</td>
<td></td>
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<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Applicability</td>
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<tr>
<td>12.g.4</td>
<td>In-cloud effects such as variable cloud density, speed cues and ambient changes should be provided.</td>
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<tr>
<td>12.g.5</td>
<td>The effect of multiple cloud layers representing few, scattered, broken and overcast conditions giving partial or complete obstruction of the ground scene.</td>
<td></td>
</tr>
<tr>
<td>12.g.6</td>
<td>Gradual break-out to ambient visibility/RVR, defined as up to 10% of the respective cloud base or top, 20 ft ≤ transition layer ≤ 200 ft; cloud effects should be checked at and below a height of 600 m (2 000 ft) above the airport and within a radius of 16 km (10 sm) from the airport. 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.</td>
<td></td>
</tr>
<tr>
<td>12.g.7</td>
<td>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 airport and within a radius of 16 km (10 sm) from the airport.</td>
<td></td>
</tr>
<tr>
<td>12.g.8</td>
<td>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 &gt; IOS RVR.</td>
<td></td>
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<tr>
<td>12.g.9</td>
<td>Effects of fog on airport lighting such as halos and defocus.</td>
<td></td>
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<tr>
<td>12.g.10</td>
<td>Effect of ownship lighting in reduced visibility, such as reflected glare, to include landing lights, strobes, and beacons.</td>
<td></td>
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<tr>
<td>12.g.11</td>
<td>Wind cues to provide the effect of blowing snow or sand across a dry runway or taxiway should be selectable from the instructor station.</td>
<td></td>
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<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Applicability</td>
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<tr>
<td>13</td>
<td><strong>Motion effects</strong></td>
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<tr>
<td></td>
<td>The following specific motion 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 should be representative of the aeroplane.</td>
<td></td>
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<tr>
<td>13.a</td>
<td>Taxiing effects such as lateral and directional cues resulting from steering and braking inputs</td>
<td></td>
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<tr>
<td>13.b</td>
<td>Effects of runway rumble, oleo deflections, ground speed, uneven runway, runway centre line lights, runway contamination with associated anti-skid and taxiway characteristics</td>
<td></td>
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<tr>
<td>13.c</td>
<td>Buffets on the ground due to spoiler/speedbrake extension and thrust</td>
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<tr>
<td>13.d</td>
<td>Bumps associated with the landing gear</td>
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<tr>
<td>13.e</td>
<td>Buffet during extension and retraction of landing gear</td>
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<tr>
<td>13.f</td>
<td>Buffet in the air due to flap and spoiler/speedbrake extension</td>
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<tr>
<td>13.g</td>
<td>Buffet due to atmospheric disturbances</td>
<td></td>
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<tr>
<td>13.h</td>
<td>Approach to stall buffet</td>
<td></td>
</tr>
<tr>
<td>13.i</td>
<td>Touchdown cues for main and nose gear</td>
<td></td>
</tr>
<tr>
<td>13.j</td>
<td>Nosewheel scuffing</td>
<td></td>
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<tr>
<td>13.k</td>
<td>Thrust effect with brakes set</td>
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<tr>
<td>13.l</td>
<td>Mach and manoeuvre buffet</td>
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<tr>
<td>13.m</td>
<td>Tire failure dynamics</td>
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<tr>
<td>13.n</td>
<td>Engine failures, malfunction, engine and airframe structural damage</td>
<td></td>
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<tr>
<td>13.o</td>
<td>Tail, engine pod/propeller, wing strikes</td>
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<tr>
<td>13.p</td>
<td>Other</td>
<td></td>
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<td>14</td>
<td><strong>Sound system</strong></td>
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<tr>
<td>14.a</td>
<td>Precipitation</td>
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<tr>
<td>14.b</td>
<td>Rain removal equipment</td>
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<tr>
<td>14.c</td>
<td>Significant aeroplane noises perceptible to the pilot during normal operations, such as engine, propeller, flaps, gear, anti-skid, spoiler extension/retraction, thrust reverser to a comparable level of that found in the aeroplane</td>
<td></td>
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<tr>
<td>14.d</td>
<td>Abnormal operations for which there are associated sound cues including, but not limited to, engine malfunctions, landing gear/tire malfunctions, tail and engine pod/propeller strike and pressurization malfunction</td>
<td></td>
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<tr>
<td>14.e</td>
<td>Sound of a crash when the FSTD is landed in excess of limitations</td>
<td></td>
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<tr>
<td>15</td>
<td><strong>Special effects</strong></td>
<td></td>
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<tr>
<td>15.a</td>
<td>Braking dynamics (normal and anti-skid, failure dynamics for brakes and anti-skid, reduced efficiency due to high temperature, etc.)</td>
<td></td>
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<tr>
<td>15.b</td>
<td>Effects of airframe and engine icing</td>
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<td>16</td>
<td><strong>Air traffic control (ATC) environment simulation system</strong></td>
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<td>16.a</td>
<td>Dynamic automated environment</td>
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<td>16.b</td>
<td>Voice initiated transmissions, background traffic</td>
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<td>16.c</td>
<td>Automated weather reporting</td>
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<td>16.d</td>
<td>Party-line (background chatter)</td>
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<td>16.e</td>
<td>Simulated communications system interaction with simulator</td>
<td></td>
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<td>16.f</td>
<td>Communication simulation interaction with instructor</td>
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<tr>
<td>16.g</td>
<td>Message triggering</td>
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<td>16.h</td>
<td>Datalink communications</td>
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<tr>
<td>16.i</td>
<td>Correlation with other traffic</td>
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<td>16.j</td>
<td>Phraseology</td>
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<td>16.k</td>
<td>Flight phase specific ATC frequency recognition</td>
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<tr>
<td>16.l</td>
<td>Other communication (dispatch, maintenance, cabin crew, etc.)</td>
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<tr>
<td>16.m</td>
<td>Instructor over-ride of the system</td>
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<tr>
<td>16.n</td>
<td>Other</td>
<td></td>
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<td>17</td>
<td><strong>Instructor Operating Station</strong></td>
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<tr>
<td>17.a</td>
<td><strong>Repositions</strong> (repositions should be in-trim at the appropriate speed and configuration for the point):</td>
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<tr>
<td>17.a.1</td>
<td>Ramp/gate</td>
<td></td>
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<tr>
<td>17.a.2</td>
<td>Take-off</td>
<td></td>
</tr>
<tr>
<td>17.a.3</td>
<td>Approach</td>
<td></td>
</tr>
<tr>
<td>17.a.4</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Applicability</td>
</tr>
<tr>
<td>--------</td>
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</tr>
<tr>
<td>17.b</td>
<td>Resets:</td>
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</tr>
<tr>
<td>17.b.1</td>
<td>System</td>
<td></td>
</tr>
<tr>
<td>17.b.2</td>
<td>Temperature</td>
<td></td>
</tr>
<tr>
<td>17.b.3</td>
<td>Fluids and agents</td>
<td></td>
</tr>
<tr>
<td>17.c</td>
<td>Environment:</td>
<td></td>
</tr>
<tr>
<td>17.c.1</td>
<td>Weather presets:</td>
<td></td>
</tr>
<tr>
<td>17.c.1.a</td>
<td>Unlimited, CAVOK, VFR, non-precision, precision (CAT I, CAT II, CAT III), EFVS (if appropriate)</td>
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<tr>
<td>17.c.1.b</td>
<td>Unlimited, CAVOK, VFR</td>
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<tr>
<td>17.c.2</td>
<td>Visual effects:</td>
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</tr>
<tr>
<td>17.c.2.a</td>
<td>Time of day (day, dusk, night); clouds (bases, tops, layers, types, density); visibility in kilometres/statute miles; RVR in metres/feet; and special effects (precipitation; thunder storms; blowing snow, sand, etc.)</td>
<td></td>
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<tr>
<td>17.c.2.b</td>
<td>Time of day (day, dusk, night); clouds (bases, tops, layers, types, density); visibility in kilometres/statute miles; RVR in metres/feet; and special effects (precipitation; thunder storms)</td>
<td></td>
</tr>
<tr>
<td>17.c.2.c</td>
<td>Time of day (day, dusk, night); clouds (bases, tops); visibility in kilometres/statute miles</td>
<td></td>
</tr>
<tr>
<td>17.c.3</td>
<td>Wind:</td>
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</tr>
<tr>
<td>17.c.3.a</td>
<td>Surface</td>
<td></td>
</tr>
<tr>
<td>17.c.3.b</td>
<td>Intermediate levels</td>
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<tr>
<td>Number</td>
<td>Functions and Subjective Tests</td>
<td>Applicability</td>
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<td>17.c.3.c</td>
<td>Typical gradient</td>
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<tr>
<td>17.c.3.d</td>
<td>Gust with associated heading and speed variance</td>
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<tr>
<td>17.c.3.e</td>
<td>Turbulence</td>
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<td>17.c.4</td>
<td><strong>Temperature</strong> – surface</td>
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<tr>
<td>17.c.5</td>
<td><strong>Atmospheric pressure</strong> (QNH, QFE)</td>
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<tr>
<td>17.d</td>
<td><strong>Airport:</strong></td>
<td></td>
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<tr>
<td>17.d.1</td>
<td><strong>Runway selection</strong></td>
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</tr>
<tr>
<td>17.d.1.a</td>
<td>To include active runway selection, and as appropriate to the airport, should be able to light at least one additional parallel or crossing runway</td>
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<tr>
<td>17.d.1.b</td>
<td>To include active runway selection</td>
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<tr>
<td>17.d.2</td>
<td><strong>Airport lighting</strong></td>
<td></td>
</tr>
<tr>
<td>17.d.2.a</td>
<td>Airport lighting including variable intensity and control of progressive low visibility taxiway and stop bar lighting, as appropriate</td>
<td></td>
</tr>
<tr>
<td>17.d.2.b</td>
<td>Airport lighting</td>
<td></td>
</tr>
<tr>
<td>17.d.3</td>
<td>Dynamic effects including ground and flight traffic</td>
<td></td>
</tr>
<tr>
<td>17.e</td>
<td>Aeroplane configuration (fuel, weight, cg, etc.)</td>
<td></td>
</tr>
<tr>
<td>17.f</td>
<td>FMS - reloading of programmed data unless precluded by installed equipment</td>
<td></td>
</tr>
<tr>
<td>17.g</td>
<td>Plotting and recording (take-off and approach)</td>
<td></td>
</tr>
<tr>
<td>17.h</td>
<td>Malfunctions (inserting and removing)</td>
<td></td>
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</tbody>
</table>
Appendix D

Future Doc 9625 (MCQFSTD) updates

Please refer to Volume I, Part II, Appendix D.
ATTACHMENTS A to O

GUIDANCE MATERIAL

Please refer to Volume I, Part II, Attachments A to O for relevant guidance material.

— END —