EGYPTIAN CIVIL AVIATION AUTHORITY

# EAC
# No. 121_1

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# Subpart A
# Airplane Simulator Qualification

## 1. PURPOSE.

This Subpart provides an acceptable means, but not the only means, of compliance with Egyptian Civil Aviation regulations, regarding the evaluation and qualification of airplane simulators used in training programs or airmen checking.

## 2. SIMULATORS DESIGNATIONS.

The simulators designations and their relationships with the simulator definitions used previously and in Part121, App. H, are: Level A - Visual, Level B - Phase I, Level C - Phase II, Level D - Phase III

Nonvisual simulators are grouped with Level 6 training devices, but must meet the requirements, except for visual, of a Level A simulator. Alphabetic designations were chosen for simulators to maintain a distinction from the numerically designated training devices.

## 3 . DEFINITIONS.

a. Aircraft Simulator is a full-size replica of a specific type or make, model, and series cockpit, including the assemblage of equipment and computer programs necessary to represent the aircraft in ground and flight operations, a visual system providing an out-of-the-cockpit view, and a force cuing system which provides cues at least equivalent to that of a three degrees-of-freedom motion system; and is in compliance with the minimum standards for Level A simulator.

b. Approval Test Guide (ATG) is a document designed to validate that the performance and handling qualities of a simulator agree within prescribed limits with those of the aircraft and that all applicable regulatory requirements have been met. The ATG includes both the aircraft and simulator data used to support the validation. The Master Approval Test Guide (MATG) is the ECAA approved ATG and incorporates the results of ECAA witnessed tests. The MATG serves as the reference for future evaluations.

c. Convertible Simulator is a simulator in which hardware and software can be changed so that the simulator becomes a replica of a different model, usually of the same type aircraft. Thus, the same simulator platform, cockpit shell, motion system, visual system, computers, and necessary peripheral equipment can be used in more than one simulation.

d. Highlight Brightness is the area of maximum displayed brightness which satisfies the brightness test in appendix 1, item 4k.

e. Latency is the additional time beyond that of the basic aircraft perceivable response time due to the response time of the simulator. This includes the update rate of the computer system combined with the respective time delays of the motion system, visual system or instruments.

f. Operator, as used in this EAC, identifies the person or organization requesting ECAA qualification of a simulator or flight training device and is responsible for continuing qualification and liaison with the ECAA.

g. Simulation Data are the various types of data used by the simulator manufacturer and the applicant to design, manufacture, and test the flight simulator. Normally, the aircraft manufacturer will supply aircraft data to the simulator manufacturer.

h. Snapshot is a presentation of one or more variables at a given instant of time. A snapshot is appropriate for a steady-state condition in which the variables are constant with time.

i. Statement of Compliance (SOC) is a certification from the operator that specific requirements have been met. It must provide references to needed sources of information for showing compliance, rationale to explain how the referenced material is used, mathematical equations and parameter values used, and conclusions reached.

j. Time History is a presentation of the change of a variable with respect to time. It is usually in the form of a continuous data plot over the time period of interest or a printout of test parameter values recorded at multiple constant time intervals over the time period of interest.

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

l. Upgrade, for the purpose of this EAC, means the improvement or enhancement of a simulator for the purpose of achieving a higher level qualification.

m. Validation Flight Test Data, for the purpose of this EAC, are performance, stability and control, and other necessary test parameters electrically or electronically recorded in an airplane using a calibrated data acquisition system of sufficient resolution and verified as accurate by the company performing the test to establish a reference set of relevant parameters to which like simulator parameters can be compared. Other data, such as photographic data, may be considered acceptable flight test data after evaluation.

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

## 4 . EVALUATION POLICY.

a. The methods, procedures, and standards defined in this EAC provide one means, acceptable to the ECAA, to evaluate and qualify a simulator. If an applicant desires to use another means, a proposal must be submitted for review and approval prior to the submittal of a detailed ATG. If an applicant chooses to utilize the approach described in this EAC, the applicant must adhere to all of the methods, procedures, and standards herein.

b. The simulator must be assessed in those areas which are essential to completing the airman training and checking process. This includes the simulator's longitudinal and lateral-directional responses; performance in takeoff, climb, cruise, descent, approach, and landing; control checks; cockpit, flight engineer, and instructor station functions checks; and certain additional requirements depending upon the complexity or qualification level of the simulator. The motion system and visual system will be evaluated to ensure their proper operation.

c. The intent is to evaluate the simulator as objectively as possible. Pilot acceptance, however, is also an important consideration. Therefore, the simulator will be subjected to validation tests listed in appendix 2 of this EAC and the functions and subjective tests from appendix 3. These tests include a qualitative assessment of the simulator by an ECAA pilot who is qualified in the respective airplane. Validation tests are used to compare objectively simulator and airplane data to assure that they agree within specified tolerances. Functions tests provide a basis for evaluating simulator capability to perform over a typical training period and to verify correct operation of the simulator controls, instruments, and systems.

d. Tolerances, listed for parameters in appendix 2, should not be confused with design tolerances specified for simulator manufacture. Tolerances for the parameters listed in appendix 2 are the maximum acceptable to the ECAA for simulator validation.

e. A convertible simulator will be addressed as a separate simulator for each model and series to which it will be converted and ECAA qualification sought. An ECAA evaluation is required for each configuration. For example, if an operator seeks qualification for two models of an airplane type using a convertible simulator, two ATGs or a supplemented ATG, and two evaluations are required.

f. If a problem with a validation test result is detected by the ECAA Simulator Evaluation Specialist, the test may be repeated. If it still does not meet the test tolerance, the operator may demonstrate alternative test results which relate to the test in question. In the event a validation test(s) does not meet specified criteria, but the criteria is not considered critical to the level of evaluation being conducted. The operator will be given a specified period of time to correct the problem and submit the ATG changes to the ECAA for evaluation. Alternatively, if it is determined that the results of a validation test would have a detrimental effect on the level of qualification being sought or is a firm regulatory requirement, the ECAA may qualify the simulator to a lesser level or restrict maneuvers based upon the evaluation completed. For example, if a Level D evaluation is requested and the simulator fails to meet landing test tolerances, it could be qualified at Level A.

g. At the discretion of the ECAA Simulator Evaluation Specialist, the operator's pilots may assist in completing the functions and validation tests during evaluations. However, only ECAA personnel should manipulate the pilot controls during the functions check portion of an ECAA evaluation.

## 5 . INITIAL OR UPGRADE EVALUATIONS.

a. An operator seeking simulator initial or upgrade evaluation must submit a request in writing to the ECAA. This request should contain a compliance statement certifying that the simulator meets all of the provisions of this EAC, that the cockpit configuration conforms to that of the airplane, that specific hardware and software configuration control procedures have been established, and that the pilot(s) designated by the operator confirm that it is representative of the airplane in all functions test areas. A sample letter of request is included in appendix 4.

b. The operator should submit an ATG which includes:

(1) A title page with the operator and ECAA approval signature blocks.

(2) A simulator information page, for each configuration in the case of convertible simulators, providing:

(i) The operator's simulator identification number or code.
(ii) Airplane model and series being simulated.
(iii) Aerodynamic data revision.
(iv) Engine model and its data revision.
(v) Flight control data revision.
(vi) Flight Management System identification and revision level.
(vii) Simulator model and manufacturer.
(viii) Date of simulator manufacture.
(ix) Simulator computer identification.
(x) Visual system model and manufacturer.
(xi) Motion system type and manufacturer.

(3) Table of contents.
(4) Log of revision and/or list of effective pages.
(5) Listing of all reference source data.
(6) Glossary of terms and symbols used.
(7) SOC with certain requirements. SOCs must provide references to sources of information for showing compliance, rationale to explain how the referenced material is used, mathematical equations and parameter values used, and conclusions reached. Refer to appendix 1, "Simulator Standards," comments column, for SOC requirements.
(8) Recording procedures or required equipment for the validation tests.
(9) The following for each validation test designated in appendix 2 of this EAC:

(i) Name of the test.
(ii) Objective of the test.
(iii) Initial conditions.
(iv) Manual test procedures.
(v) Automatic test procedures (if applicable).
(vi) Method for evaluating simulator validation test results.
(vii) Tolerances for relevant parameters.
(viii) Source of Airplane Test Data (document and page number).
(ix) Copy of Airplane Test Data.
(x) Simulator Validation Test Results as obtained by the operator.
(xi) A means, acceptable to the ECAA, of easily comparing the simulator test results to airplane test data.

c. The operator's simulator test results must be recorded on a multi-channel recorder, line printer, or other appropriate recording media acceptable to the ECAA. Simulator results should be labeled using terminology common to airplane parameters as opposed to computer software identifications. These results should be easily compared with the supporting data by employing cross-plotting, overlays, transparencies, or other acceptable means. Airplane data documents included in an ATG may be photographically reduced only if such reduction will not alter the graphic scaling or cause difficulties in scale interpretation or resolution. Incremental scales on graphical presentations must provide the resolution necessary for evaluation of the parameters shown in appendix 2. The test guide will provide the documented proof of compliance with the simulator validation tests in appendix 2. In the case of a simulator upgrade, an operator should run all validation tests for the requested qualification level. Validation test results offered in a test guide for a previous initial or upgrade evaluation should not be used to validate simulator performance in a test guide offered for a current upgrade. For tests involving time histories, flight test data sheets, or transparencies thereof, and simulator test results should be clearly marked with appropriate reference points to ensure an accurate comparison between simulator and airplane with respect to time. Operators using line printers to record time histories should clearly mark that information taken from the line printer data output for cross-plotting on the airplane data. The cross-plotting of the operator's simulator data to airplane data is essential to verify simulator performance in each test. During an evaluation, the ECAA will devote its time to detailed checking of selected tests from the ATG. The ECAA evaluation serves to validate the operator's simulator test results.

d. The completed ATG and the operator's compliance letter and request for the evaluation will be submitted through the operator with a letter of memorandum of endorsement to the ECAA. The ATG will be reviewed and determined to be acceptable prior to scheduling an evaluation of the simulator.

e. A copy of an ATG for each type simulator by each simulator manufacturer will be required for the ECAA's file. The ECAA may elect not to retain copies of the ATG for subsequent simulators of the same type by a particular manufacturer, but will determine the need for copies on a case-by-case basis. Data updates to an original ATG should be provided to the ECAA in order to keep file copies current.

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

g. In the event an operator moves a simulator to a new location and its level of qualification is not changed, the following procedures shall apply:
   (1) Advise the ECAA of the move.
   (2) Prior to returning the simulator to service at the new location, the operator should perform a typical recurrent validation and functions test. The results of such tests will be retained by the operator and be available for inspection by the ECAA at the next evaluation or as requested.
   (3) The ECAA may schedule an evaluation prior to return to service.

h. When there is a change of operator, the new operator must accomplish all required administrative procedures including the submission of the currently approved Master Approval Test Guide (MATG) through the previous operator to the ECAA. The ATG must be identified with the new operator by displaying the operator's name or logo. The operator will then submit the package as described in paragraph 5d above. The simulator may, at the discretion of the ECAA, be subject to an evaluation in accordance with the original qualification criteria.

i. The scheduling priority for initial and upgrade evaluations will be based on the sequence in which acceptable ATGs and evaluation requests are received by the ECAA.

j. The ATG will be approved after the completion of the initial or upgrade evaluation and all discrepancies in the ATG have been corrected. This document, after inclusion of the ECAA witnessed test results, becomes the MATG. The MATG will then remain in the custody of the operator for use in future recurrent evaluations.

## 6 . RECURRENT EVALUATIONS.

a. For a simulator to retain its qualification, it will be evaluated on a recurrent basis using the approved MATG. Unless otherwise determined by the ECAA, recurring evaluations will be accomplished every 4 months by a Simulator Evaluation Specialist. Each recurrent evaluation, normally scheduled for 8 hours of simulator time, will consist of functions tests and approximately one-third of the validation tests in the MATG. The MATG is to be completed annually.

b. Dates of recurrent evaluations will normally not be scheduled beyond 30 days of the date due. Exceptions to this policy will be considered by the ECAA on a case-by-case basis to address extenuating circumstances.

c. In the interest of conserving simulator time, the following Optional Test Program (OTP) is an alternative to the 8-hour recurrent evaluation procedure:

(1) Operators of simulators having the appropriate automatic recording and plotting capabilities may apply for evaluation under the OTP.

(2) Operators must notify the ECAA in writing of their intent to enter the OTP. If the ECAA determines that the evaluation can be accommodated with 4 hours or less of simulator time, recurrent evaluations for that simulator will be planned for 4 hours. If the 4-hour period is or will be exceeded and the operator cannot extend the period, then the evaluation will be terminated and must be completed within 30 days to maintain qualification status. The ECAA will then reassess the appropriateness of the OTP.

(3) Under the OTP, at least one-third of all the validation tests will be performed and certified by operator personnel between ECAA recurrent evaluations. Complete coverage will be required through any three consecutive recurrent evaluations. These tests and results will be reviewed by the ECAA Simulator Evaluation Specialist at the outset of each evaluation. The one-third of validation tests executed for each evaluation should be accomplished within the 30 days prior to the scheduled evaluation or accomplished on an evenly distributed basis during the 4-month period preceding the scheduled evaluation. Twenty percent of those tests conducted by the operator for each recurrent evaluation will then be selected and repeated by the Simulator Evaluation Specialist along with 10 percent of those tests not performed by the operator.

d. With appropriate arrangement and understanding between the operator and ECAA, an extended interval recurrent evaluation schedule based on semiannual ECAA inspections can be arranged. The extended interval evaluation schedule relies on quarterly checks by the operator.

e. Prior to arrival for an on-site evaluation, the ECAA inspector will notify the operator if any tests are planned to be run that may require special equipment or technicians. These tests would include latencies, control dynamics, sounds and vibrations, or motion system tests.

f. In instances where an operator plans to remove a simulator from active status for prolonged periods, the following procedures shall apply to re-qualify the simulator pursuant to this AC:

(1) The ECAA shall be advised in writing. The notice shall contain an estimate of the period that the simulator will be inactive.

(2) Recurrent evaluations will not be scheduled during the inactive period. The ECAA will remove the simulator from qualified status on a mutually established date not later than the date on which the first missed recurrent evaluation would have been scheduled.

(3) Before a simulator can be restored to ECAA qualified status, it will require an evaluation by the ECAA. The evaluation content and time required for accomplishment will be based on the number of recurrent evaluations missed during the inactive period. For example, if the simulator were out of service for 1 year, it would be necessary to complete the entire test guide since under the recurrent evaluation program, the MATG is to be completed annually.

(4) The operator will notify the ECAA of any changes to the original scheduled time out of service.

(5) The simulator will normally be re-qualified using the ECAA approved MATG and criteria that was in effect prior to its removal from qualification; however, inactive periods exceeding 1 year will require a review of the qualification basis.

(6) If these procedures are not possible, the establishment of a new qualification basis will be necessary.

## 7 . SPECIAL EVALUATIONS.

a. Between recurring evaluations, if deficiencies are discovered or it becomes apparent that the simulator is not being maintained to initial qualification standards, a special evaluation of the simulator may be conducted by the ECAA to verify its status.

b. The simulator will lose its qualification when the ECAA can no longer ascertain maintenance of the original simulator validation criteria based on a recurrent or special evaluation. Additionally, the operator shall advise the ECAA if a deficiency is jeopardizing training requirements, and arrangements shall be made to resolve the deficiency in the most effective manner, including the withdrawal of approval by the operator.

## 8. MODIFICATION OF SIMULATORS, MOTION SYSTEMS, AND VISUAL SYSTEMS.

a. In accordance with Part 121, Appendix H, operators must notify ECAA at least 21 days prior to making software program or hardware changes which might impact flight or ground dynamics of a simulator. A complete list of these planned changes, including dynamics related to the motion and visual systems and any necessary updates to the MATG, must be provided in writing. Operators should maintain a configuration control system to ensure the continued integrity of the simulator as qualified. The configuration control system may be examined by the ECAA on request.

b. Modifications which impact flight or ground dynamics, systems functions, and significant ATG revisions may require an ECAA evaluation of the simulator.

## 9 . SIMULATOR QUALIFICATION BASIS.

The ECARs require that simulators must maintain their approved performance, functions, and other characteristics. .All initial, upgrade and recurrent evaluations of those simulators initially qualified according to the acceptable methods of compliance described herein will be conducted in accordance with the provisions of this EAC. Simulators approved prior to this EAC will continue to maintain their current qualifications as long as they meet the standards under which they were originally approved, regardless of operator, except as noted in paragraph 5h. Any simulator upgraded to Level B, C, or D standards or any visual system or motion system upgrade requires and initial evaluation of that simulator, visual system, or motion system in accordance with the provisions herein.

# APPENDIX 1.
# SIMULATOR STANDARDS

## 1. DISCUSSION.

This appendix describes the minimum simulator requirements for qualifying Level A, Level B, Level C, and Level D airplane simulators. An operator desiring evaluation of an airplane simulator not equipped with a visual system (non-visual simulator) must comply with Level A simulator requirements except those pertaining to visual systems. The validation and functions tests listed in appendices 2 and 3 must also be consulted when determining the requirements of a specific level simulator. For Levels C and D qualification, certain simulator and visual system requirements included in this appendix must be supported with a statement of compliance and, in some designated cases, an objective test. Compliance statements will describe how the requirement is met, such as gear modeling approach, coefficient of friction sources, etc. The test should show that the requirement has been attained. In the following tabular listing of simulator standards required statements of compliance are indicated in the comment column.

## 2. GENERAL

a. (A, B, C, D) Cockpit, a full-scale replica of the airplane simulated. Direction of movement of controls and switches identical to that in the airplane. The cockpit, for simulator purposes, consists of all that space forward of a cross-section of the fuselage at the most extreme aft setting of the pilots' seats. Additional required crewmember duty stations and those required bulkheads aft of the pilot seats are also considered part of the cockpit and must replicate the airplane.

b. (A, B, C, D) Circuit breakers that affect procedures and/or result in observable cockpit indications properly located and functionally accurate.

c. (A, B, C, D) Effect of aerodynamic changes for various combinations of drag and thrust normally encountered in flight corresponding to actual flight conditions, including the effect of change in airplane attitude, thrust, drag, altitude, temperature, gross weight, center of gravity location, and configuration.

d. (A) Ground operations generically represented to the extent that allows turns within the confines of the runway and adequate control on the landing and rollout from a crosswind approach to a running landing.

e. (A, B, C, D) All relevant instrument indications involved in the simulation of the applicable airplane automatically responded to control movement by a crewmember or external disturbances to the simulated airplane; that is, turbulence or windshear.

COMMENT: Numerical values must be presented in the appropriate units for ARE. operations, for example, fuel in pounds, speeds in knots, altitudes in feet, etc.

f. (A, B, C, D) Communications and navigation equipment corresponding to that installed in the applicant's airplane with operation within the tolerances prescribed for the applicable airborne equipment.

COMMENT: See appendix 3, paragraph 1, for further information regarding long range navigation equipment.

g. (A, B, C, D) In addition to the flight crewmember stations, two suitable seats for the instructor/check airman and ECAA inspector. The ECAA will consider options to this standard based on unique cockpit configurations. These seats must provide adequate vision to the pilot's panel and forward windows in visual system models. Observer seats need not represent those found in the airplane but must be equipped with similar positive restraint devices.

h. (A, B, C, D) Simulator systems must simulate the applicable system operation, both on the ground and in flight. Systems must be operative to the extent that normal, abnormal, and emergency operating procedures appropriate to the simulator application can be accomplished.

i. (A, B, C, D) Instructor controls to enable the operator to control all required system variables and insert abnormal or emergency conditions into the airplane systems.

j. (A, B, C, D) Control forces and control travel which correspond to that of the replicated airplane. Control forces should react in the same manner as in the airplane under the same flight conditions.

k. (A, B, C, D) Significant cockpit sounds which result from pilot actions corresponding to those of the airplane.

l. (C, D) Sound of precipitation, windshield wiper, and other significant airplane noises perceptible to the pilot during normal operations and the sound of a crash when the simulator is landed in excess of landing gear limitation.

*COMMENT*: Statement of Compliance.

m. (D) Realistic amplitude and frequency of cockpit noises and sounds, including precipitation, static and engine and airframe sounds. The sounds shall be coordinated with the weather representations required in Part 121, Appendix H, Phase III (Level D), Visual Requirement No. 3.

*COMMENT*: Tests required for noises and sounds that originate from the airplane or airplane systems.

n. (B, C, D) Ground handling and aerodynamic programming to include:

*COMMENT*: Statement of Compliance. Tests required.

(1) Ground effect - for example: roundout, flare, and touchdown. This requires data on lift, drag, pitching moment, trim, and power in ground effect.

(2) Ground reaction - reaction of the airplane upon contact with the runway during landing 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.

(3) Ground handling characteristics - steering inputs to include crosswind, braking, thrust reversing, deceleration, and turning radius.

o. (C, D) Windshear models which provide training in the specific skills required for recognition of windshear phenomena and execution of recovery maneuvers. Such models must be representative of measured or accident derived winds, but may include simplifications which ensure repeatable encounters. For example, models may consist of independent variable winds in multiple simultaneous components. Wind models should be available for the following critical phases of flight:

COMMENT: Tests required.

(1) Prior to takeoff rotation.
(2) At liftoff.
(3) During initial climb.
(4) Short final approach.

The ECAA Windshear Training Aid presents one acceptable means of compliance with simulator wind model requirements. The ATG should either reference the ECAA Windshear Training Aid or present airplane related data on alternate methods implemented.

p. (A, B, C, D) Representative crosswinds and instructor controls for wind speed and direction.

q. (C, D) Representative stopping and directional control forces for at least the following runway conditions based on airplane related data.

(1) Dry
(2) Wet
(3) Icy
(4) Patchy Wet
(5) Patchy Icy
(6) Wet on Rubber Residue in Touchdown Zone

COMMENT: Statement of Compliance. Objective tests required for (1), (2), (3), Subjective check for (4), (5), (6).

r. (C, D) Representative brake and tire failure dynamics (including anti-skid) and decreased brake efficient {sic} due to brake temperature based on airplane related data.

COMMENT: Statement of Compliance. Tests required for decreased braking efficiency due to brake temperature.

s. (C, D) A means for quickly and effectively testing similar programming and hardware. This may include an automated system which could be used for conducting at least a portion of the tests in the ATG.

COMMENT: Statement of Compliance.

t. (A, B, C, D) Simulator computer capacity, accuracy, resolution, and dynamic response sufficient for the qualification level sought.

COMMENT: Statement of Compliance. Part 121, Appendix H, specifies computer standard for Phases II and III (Levels C and D).

u. (C, D) Control feel dynamics which replicate the airplane simulated. Free response of the controls shall match that of the airplane within the tolerance given in appendix 2. Initial and upgrade evaluation will include control-free response (column, wheel, and pedal) measurements recorded at the controls. The measured responses must correspond to those of the airplane in takeoff, cruise, and landing configurations.

*COMMENT*: Tests required. See appendix 2, paragraph 3.

(1) For airplanes with irreversible control systems, measurements may be obtained on the ground if proper pitot static inputs are provided to represent conditions typical of those encountered in flight. Engineering validation or airplane manufacturer rationale will be submitted as justification to ground test or omit a configuration.

(2) For simulators requiring static and dynamic tests at the controls, special test fixtures will not be required during initial evaluations if the operator's ATG shows both test fixture results and alternate test method results, such as computer data pilots, which were obtained concurrently. Repeat of the alternate method during the initial evaluation may then satisfy this test requirement.

v. (A, B, C, D) Relative responses of the motion system, visual system, and cockpit instruments shall be coupled closely to provide integrated sensory cues. These systems shall respond to abrupt pitch, roll and yaw inputs at the pilot's position within 150/300 milliseconds of the time, but not before the time, when the airplane would respond under the same conditions. Visual scene changes from steady-state disturbance shall occur within the system dynamic response limit of 150/300 milliseconds but not before the resultant motion onset. The test to determine compliance with these requirements should include simultaneously recording the analog output from the pilot's control column, wheel, and pedals, the output from an accelerometer attached to the motion system platform located at an acceptable location near the pilots' seats, the output signal to the pilots' seats, the output signal to the visual system display (including visual system analog delays), and the output signal to the pilot's attitude indicator or an equivalent test approved by the Administrator. The test results in a comparison of a recording of the simulator's response to actual airplane response data in the takeoff, cruise, and landing configuration. The intent is to verify that the simulator system transport delays or time lags are less than 150/300 milliseconds and that the motion and visual cues relate to actual airplane responses. For airplane response, acceleration in the appropriate rotational axis is preferred.

As an alternative, a transport delay test may be used to demonstrate that the simulator system does not exceed the specified limit of 150/300 milliseconds.

This test shall measure all the delay encountered by a step signal migrating from the pilots' control through the control loading electronics and interfacing through all the simulation software modules in the correct order, using a handshaking protocol, finally through the normal output interfaces to the motion system, to the visual system and instrument displays. A recordable start time for the test should be provided by a pilot flight control input. The test mode shall permit normal computation time to be consumed and shall not alter the flow of information through the hardware/software system. The transport delay of the system is then the time between the control input and the individual hardware responses. It need only be measured once in each axis, being independent of flight conditions.

COMMENT: Tests required: for Levels A and B, response must be within 300 milliseconds, for Levels C and D, response must be within 150 milliseconds.

w. (D) Aerodynamic modeling which, for airplanes issued an original type certificate after June 1980, includes low altitude level flight ground effect, Mach effect at high altitude, effects of airframe icing, normal and reverse dynamic thrust effect on control surfaces, aeroelastic representations and representations of nonlinearities due to sideslip based on airplane flight test data provided by the manufacturer.

COMMENT: Statement of Compliance. Tests required. See appendix 2, paragraph 4, for further information on ground effect. Mach effect, aeroelastic representations, and nonlinearities due to sideslip are normally included in the simulator aerodynamic model, but the Statement of Compliance must address each of them. Separate tests for thrust effects and a Statement of Compliance and demonstration of icing effects are required.

x. (B, C, D) Aerodynamic and ground reaction modeling for the effects of reverse thrust on directional control.

COMMENT: Statement of Compliance. Tests required.

y. (D) Self-testing for simulator hardware and programming to determine compliance with simulator performance tests as prescribed in appendix 2. Evidence of testing must include simulator number, date, time, conditions, tolerances, and appropriate dependent variables portrayed in comparison to the airplane standard. Automatic flagging of "out-of-tolerance" situations is encouraged.

COMMENT: Statement of Compliance. Tests required.

z. Diagnostic analysis printouts of simulator malfunctions sufficient to determine compliance with the Simulator Component Inoperative Guide (SCIG). These printouts shall be retained by the operator between recurring ECAA simulator evaluations as part of the daily discrepancy log required under Part 121.407(a)(5).

COMMENT: Statement of Compliance.

aa. (A, B, C, D) Timely permanent update of simulator hardware and programming subsequent to airplane modification.

bb. (A, B, C, D) Daily preflight documentation either in the daily log or in a location easily accessible for review.

## 3. MOTION SYSTEMS.

a. (A, B, C, D) Motion (force) cues perceived by the pilot representative of the airplane motions, that is, touchdown cues, should be a function of the simulated rate of descent.

b. (A, B) A motion system having a minimum of three degrees of freedom.

c. (C, D) A motion system which produces cues at least equivalent to those of a six-degrees-of-freedom synergistic platform motion system.

COMMENT: Statement of Compliance. Tests required.

d. (A, B, C, D) A means for recording the motion response time for comparison with airplane data.

COMMENT: See 2.v. of this appendix.

e. (B, C, D) Special effects programming to include:

(1) Runway rumble, oleo deflections, effects of ground speed and uneven runway characteristics.
(2) Buffets on the ground due to spoiler/speedbrake extension and thrust reversal.
(3) Bumps after liftoff of nose and main gear.
(4) Buffet during extension and retraction of landing gear.
(5) Buffet in the air due to flap and spoiler/speedbrake extension.
(6) Stall buffet to, but not necessarily beyond, the ECAA certificated stall speed, Vs.
(7) Representative touchdown cues for main and nose gear.
(8) Nose wheel scuffing.
(9) Thrust effect with brakes set.

f. (D) Characteristic buffet motions that result from operation of the airplane (for example, high speed buffet, extended landing gear, flaps, nose wheel scuffing, stall) which can be sensed at the flight deck. The simulator must be programmed and instrumented in such a manner that the characteristic buffet modes can be measured and compared to airplane data. Airplane data are also required to define flight deck motions when the airplane is subjected to atmospheric disturbances. General purpose disturbance models that approximate demonstrable flight test data are acceptable. Tests with recorded results which allow the comparison of relative amplitudes versus frequency are required.

*COMMENT*: Statement of Compliance. Tests required.

## 4. VISUAL SYSTEMS.

a. (A, B, C, D) Visual system capable of meeting all the standards of this appendix and appendices 2 and 3 (Validation and Functions and Subjective Tests Appendices) as applicable to the level of qualification requested by the applicant.

b. (A, B) Optical system capable of providing at least a 45 degrees horizontal and 30 degrees vertical field of view simultaneously for each pilot.

c. (C, D) Continuous minimum collimated visual field of view of 75 degrees horizontal and 30 degrees vertical per pilot seat. Both pilot seat visual systems shall be able to be operated simultaneously.

COMMENT: Wide angle systems providing cross-cockpit viewing must provide a minimum of 150 degrees pilot horizontal field of view; 75 degrees per pilot seat operated simultaneously.

d. (A, B, C, D) A qualified means for recording the visual response time for visual systems.

e. (A, B, C, D) Verification of visual ground segment and visual scene content at a decision height on landing approach. The ATG should contain appropriate calculations and a drawing showing the pertinent data used to establish the airplane location and visual ground segment. Such data should include, but is not limited to:

(1) Airport and runway used.
(2) Glideslope transmitter location for the specified runway.
(3) Position of the glideslope receiver antenna relative to the airplane main landing wheels.
(4) Approach and runway light intensity setting.
(5) Airplane pitch angle.

The above parameters should be presented for the airplane in landing configuration and a main wheel height of 100 feet (30 meters) above the touchdown zone. The visual ground segment and scene content should be determined for a runway visual range of 1,200 feet or 350 meters.

f. (A, B, C, D) For the ECAA to qualify precision weather minimum accuracy on simulators qualified under previous advisory circulators, operators must provide the information required in e. above.

g. (B, C, D) Visual cues to assess sink rate and depth perception during takeoff and landing.

h. (C, D) Test procedures to quickly confirm visual system color, RVR, focus, intensity, level, horizon, and attitude as compared to the simulator attitude indicator.

COMMENT: Statement of Compliance. Tests required.

i. Dusk scene to enable identification of a visible horizon and typical terrain characteristics such as fields, roads, bodies of water.

COMMENT: Statement of Compliance. Tests required.

j. (C, D) A minimum of ten levels of occulting. This capability must be demonstrated by a visual model through each channel.

COMMENT: Statement of Compliance. Test required.

k. (D) Daylight, dusk, and night visual scenes with sufficient scene content to recognize airport, the terrain, and major landmarks around the airport and to successfully accomplish a visual landing. The daylight visual scene must be part of a total daylight cockpit environment which at least represents the amount of light in the cockpit on an overcast day. Daylight visual system is defined as a visual system capable of producing, as a minimum, full-color presentations, scene content comparable in detail to that produced by 4,000 edges or 1,000 surfaces for daylight and 4,000 light points for night and dusk scenes, 6 foot-lamberts of light measured at the pilot's eye position (highlight brightness), 3 arc-minutes resolution for the field of view at the pilot's eye, and a display which is free of apparent quantization and other distracting visual effects while the simulator is in motion. The simulator cockpit ambient lighting shall be dynamically consistent with the visual scene displayed. For daylight scenes, such ambient lighting shall neither "washout" the displayed visual scene nor fall below 5 foot-lamberts of light as reflected from an approach plate at knee height at the pilot's station and/or 2 foot-lamberts of light as reflected from the pilot's face. All brightness and resolution requirements must be validated by an a objective test and will be retested at least yearly by the ECAA. Testing may be accomplished more frequently if there are indications that the performance is degrading on an accelerated basis. Compliance of the brightness capability may be demonstrated with a test pattern of white light using a spot photometer.

COMMENT: Statement of Compliance. Tests required.

(1) Contrast Ratio. A raster drawn test pattern filling the entire visual scene (three or more channels) shall consist of a matrix of black and white squares no larger than 10 degrees and no smaller than 5 degrees per square with a white square in the center of each channel.

Measurement shall be made on the center bright square for each channel using a 1 degree spot photometer. This value shall have a minimum brightness of 2 foot-lamberts. Measure any adjacent dark squares. The contrast ratio is the bright square value divided by dark square value.

Minimum test contrast ratio result is 5:1

NOTE: Cockpit ambient light levels should be maintained at Level D (Phase III) requirements.

(2) Highlight Brightness Test. Maintaining the full test pattern described above, superimpose a highlight area completely covering the center white square of each channel and measure the brightness using the 1 degree spot photometer. Light points or light point arrays are not acceptable. Use of calligraphic capabilities to enhance raster brightness is acceptable.

(3) Resolution will be demonstrated by a test pattern of objects shown to occupy a visual angle of 3 arc-minutes in the visual scene from the pilot's eyepoint. This should be confirmed by calculations in the statement of compliance.

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

(5) Light point contrast ratio - not less than 25:1 when a square of at least 1 degree filled (that is, light point modulation is just discernible) with light points is compared to the adjacent background.

# APPENDIX 2.
# SIMULATOR VALIDATION TESTS

## 1. DISCUSSION.

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

The ATG provided by the operator must describe clearly and distinctly how the simulator will be set up and operated for each test. Use of a driver program designed to automatically accomplish the tests is encouraged for all simulators. Self-testing of simulator hardware and programming to determine compliance with all simulator requirements is specified by Part121, Appendix H, for Phase III (Level D) simulators. It is not the intent and it is not acceptable to the ECAA to test each simulator subsystem independently. Overall integrated testing of the simulator must be accomplished to assure that the total simulator system meets the prescribed standards. A manual test procedure with explicit and detailed steps for completion of each test must also be provided.

The tests and tolerances contained in this appendix must be included in the operator's ATG. Levels B, C, and D simulators must be compared to flight test data except as otherwise specified. For airplanes certificated prior to June 1980, an operator may, after reasonable attempts have failed to obtain suitable flight test data, indicate in the ATG where flight test data are unavailable or unsuitable for a specific test. For such a test, alternative data should be submitted to the ECAA for approval. Submittals for approval of data other than flight test must include an explanation of validity with respect to available flight test information.

The Table of Validation Tests of this appendix generally indicates the test results required. Unless noted otherwise, simulator tests should represent airplane performance and handling qualities at operating weights and centers of gravity (CG) typical of normal operation. If a test is supported by airplane data at one extreme weight or CG, another test supported by airplane data at mid-conditions or as close as possible to the other extreme should be included. Certain tests which are relevant only at one extreme CG or weight condition need not be repeated at the other extreme. Tests of handling qualities must include validation of augmentation devices.

Simulators for highly augmented airplanes will be validated both in the unaugmented configuration (or failure state with the maximum permitted degradation in handling qualities) and the augmented configuration. Where various levels of handling qualities result from failure states, validation of the effect of the failure is necessary. Requirements for testing will be mutually agreed to between the operator and the ECAA on a case-by-case basis.

## 2. TEST REQUIREMENTS.

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

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

a. Parameters, Tolerances, and Flight Conditions. The Table of Validation Tests of this appendix describes the parameters, tolerances, and flight conditions for simulator validation. When two tolerance values are given for a parameter, the less restrictive may be used unless otherwise indicated.

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

b. Flight Conditions Verification. When comparing the parameters listed to those of the airplane, sufficient data must also be provided to verify the correct flight condition. For example, to show that control force is within ±5 pound (2.225 daN) in a static stability test, data to show the correct airspeed, power, thrust or torque, airplane 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 airplane, but airspeed, altitude, control input, airplane configuration, and other appropriate data must also be given. All airspeed values should be clearly annotated as to indicated, calibrated, etc., and like values used for comparison.

NOTE: The application of this appendix to simulator validation requires reference to Part 121, Appendix H, to acquire full knowledge of simulator criteria for approval.

**TABLE OF VALIDATION TESTS**

---------------------------------------------------------------------------

*KEY*: \1\ = Test. \2\ = Tolerance. \3\ = Flight Condition. \4\ = Qualification Requirement. I = Initial Evaluation. R = Recurrent Evaluation. \5\ = Comments

-------------------------------------------------------------------------

## 1. PERFORMANCE

a. TAXI

(1) \1\ Minimum Radius Turn. \2\ ±3 Feet (0.9 m) or 20% of Airplane Turn Radius. \3\ Ground/Takeoff. \4\ B = IR. C = IR. D = IR

(2) \1\ Rate of Turn vs. Nose Wheel Steering Angle. \2\ ±10% or ±2°/second Turn Rate. \3\ Ground/Takeoff. \4\ B = IR. C = IR. D = IR

b. TAKEOFF

(1) \1\ Ground Acceleration Time and Distance. \2\ ±5% Time and Distance or ±5% Time and ±200. Feet (61 Meters) of Distance. \3\ Ground/Takeoff. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Unfactored aircraft certification data may be used. Acceleration Time and Distance should be recorded for a minimum of 80% of total segment. (Brake release to Vr).

(2) \1\ Minimum Control Speed Ground (Vmcg) Aerodynamic Controls Only per Applicable Airworthiness Standard, OR, Low Speed, Engine Inoperative Ground Control Characteristics. \2\ Maximum Airplane Lateral Deviation ±25% or ±5 Feet (1.5 Meters). \3\ Ground/Takeoff. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Engine failure speed must be within ±1 knot of airplane engine failure speed.

(3) \1\ Minimum Unstick Speed or equivalent as provided by the airplane manufacturer. \2\ ±3 Knots Airspeed. ±1.5° Pitch. \3\ Ground/Takeoff. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Vmu is defined as that speed at which the last main landing gear leaves the ground. Main landing Gear Strut Compression or equivalent air/ground signal should be recorded. Record as a minimum from 10 knots before start of rotation.

(4) \1\ Normal Takeoff. \2\ ±3 Knots Airspeed. ±1.5° Pitch. ±1.5° Angle-of-Attack. ±20 Feet (6 Meters) Altitude. ±5.0 lb (2.224 dN) or ±10% Column Force applies only to reversible control systems \3\ Ground/Takeoff and First Segment Climb. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Record Takeoff profile from brake release to at least 200 feet (61 meters) Above Ground Level (AGL).

(5)\1\ Critical Engine Failure on Takeoff. \2\ ±3 Knots Airspeed. ±1.5° Pitch. ±1.5° Angle-of-Attack. ±20 Feet (6 Meters) Altitude. ±2° Bank and Sideslip Angle. ±5.0 lb (2.224 dN) or ±10% Column Force* ±5.0 lb (2.224 dN) or ±10% Rudder Pedal Force* ±3.0 lb (1.334 dN) or 10% Aileron Wheel Force* .* Applies only to reversible control systems. \4\ A = IR. B = IR. C = IR .D = IR. \5\ Record Takeoff profile at maximum takeoff weight to at least 200 feet (61 meters) AGL. Engine failure speed must be within ±3 knots of airplane data.

(6) \1\ Crosswind Takeoff. \2\ ±3 Knots Airspeed. ±1.5° Pitch. ±1.5° Angle-of-Attack. ±20 Feet (6 Meters) Altitude. ±2° Bank and Sideslip Angle. ±5.0 lb

(2.224 dN) or ±10% Column Force*. ±5.0 lb (2.224 dN) or ±10% Rudder Pedal Force* . ±3.0 lb (1.334 dN) or 10% Aileron Wheel Force* . * Applies only to reversible control systems.. \3\ Ground/Takeoff and First Segment Climb. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Record Takeoff profile to at least 200 feet (61 meters) AGL with same relative wind profile as airplane test.

(7) \1\ Rejected Takeoff. \2\ Overall Distance ±?. Braking Effort ±?(to be determined). \3\ Ground. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Auto brakes will be used where applicable. Maximum braking effort, Auto or Manual.

c. CLIMB

(1) \1\ Normal Climb. All Engines Operating. \2\ ±3 knots Airspeed. ±5% or ±100 FPM (0.5 Meters/Second) Climb Rate. \3\ Climb With All Engines Operating. \4\ A = IR. B = IR. C = IR. D = IR. \5\ May be a Snapshot Test. Manufacturer's gross climb gradient may be used for flight test data.

(2) \1\ One Engine Inoperative. Second Segment Climb. \2\ ±3 knots Airspeed. ±5% or ±100 FPM (0.5 Meters/Second) Climb Rate, but not less than the ECAA Approved Flight Manual. Rate of Climb. \3\ Second Segment Climb With One Engine Inoperative. \4\ A = IR B = IR. C = IR. D = IR

(3) \1\ One Engine Inoperative. Approach Climb for Airplanes With Icing. Accountability per Approved AFM. \2\ ±3 knots Airspeed. ±5% or ±100 FPM (0.5 Meters/Second) Climb Rate, but not less than the ECAA Approved Flight Manual Rate of Climb. \3\ Approach Climb With One Engine Inoperative. \4\ A = IR .B = IR. C = IR. D = IR. \5\ May be a Snapshot Test. Manufacturer's gross climb gradient may be used for flight test data. Use near maximum landing weight.

d. STOPPING

(1) \1\ Deceleration Time and Distance, Wheel Brakes Using Manual Braking, Dry Runway (No Reverse Thrust). \2\ ±5% of Time. For distance up to 4000 feet (1220 meters) ±200 feet (61 meters) or ±10% whichever is smaller. For distance greater than 4000 feet (1220 meters) ±5% of distance.. \3\ Landing. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Time and Distance should be recorded for at least 80% of the total segment (TD to Full Stop). Brake system pressure should be available.

(2) \1\ Deceleration Time and Distance, Reverse Thrust, Dry Runway (No Wheel Braking). \2\ ±5% Time and the Smaller of ±10% or 200 feet (61 meters) of Distance. \3\ Landing. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Time and Distance should be recorded for at least 80% of the total demonstrated reverse thrust segment.

(3) \1\ Stopping Time and Distance, Wheel Brakes, Wet Runway (No Reverse Thrust). \2\ Representative Stopping Time and Distance. \3\ Landing. \4\ C = I. D = I. \5\ ECAA approved Airplane Flight Manual (AFM) data is acceptable.

e. ENGINES

(1) \1\ Acceleration. \2\ Ti ±10%. Tt ±10%. \3\ Approach or Landing. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Ti = Total time from initial throttle movement until a 10% response of a critical engine parameter.. Tt = Total time from Ti to 90% go-around power. Critical engine parameter should be a measurement of power (N1, N2, EPR, Torque, etc.). Plot from flight idle to go-around power for a rapid (slam) throttle movement.

(2) \1\ Deceleration. \2\ Ti ±10%. Tt ±10%. \3\ Ground/Takeoff. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Test from maximum takeoff power to 10% of maximum takeoff power (90% decay in power). Time history should be provided.

## 1. HANDLING QUALITIES

a. STATIC CONTROL CHECKS: Column, wheel, and pedal position vs. force shall be measured at the control. An alternate method acceptable to the ECAA in lieu of the test fixture at the controls is to instrument the simulator in an equivalent manner to the flight test airplane. The force and position data from this instrumentation can be directly recorded and matched to the airplane data. Such a permanent installation would eliminate the need for installation of external devices.

(1) \1\ Column Position vs. Force and Surface Position Calibration. \2\ ±2 lbs. (0.89 daN) Breakout. ±5 lbs. (2.224 daN) or ±10% Force. ±2° Elevator.\3\ Ground.

\4\ A = IR. B = IR. C = IR. D = IR. \5\ Uninterrupted control sweep, stop-to-stop.

(2) \1\ Wheel Position vs. Force and Surface Position Calibration. \2\ ±2 lbs. (0.89 daN) Breakout ±3 lbs. (1.334 daN) or ±10% Force. ±1° Aileron. ±3° Spoiler. \3\ Ground. \4\ A = IR. B = IR. C = IR. . D = IR. \5\ Uninterrupted control sweep, stop-to-stop.

(3) \1\ Pedal Position vs. Force and Surface Position Calibration. \2\ ±5 lbs. (2.224 daN) Breakout. ±5 lbs. (2.224 daN) or ±10% Force. ±2° Rudder. \3\ Ground. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Uninterrupted control sweep, stop-to-stop.

(4) \1\ Nose Wheel Steering Force and Position. \2\ ±2 lbs. (0.89 daN) Breakout. ±3 lbs. (1.334 daN) or ±10% Force. ±2° Nose Wheel Angle. \3\ Ground. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Uninterrupted control sweep, stop-to-stop.

(5) \1\ Rudder Pedal Steering Calibration. \2\ ±2° Nose Wheel Angle. \3\ Ground. \4\ A = IR. B = IR. C = IR. D = IR

(6) \1\ Pitch Trim Calibration Indicator vs. Computed. \2\ ±0.5° of Computer Trim Angle. ±10% Trim Rate. \3\ Ground and Go-Around. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Measure trim rate for go-around. Trim rate input and surface rate time history is appropriate.

(7) \1\ Alignment of Power Lever Angle vs. Selected Engine Parameter (EPR, N1, Torque, etc.). \2\ ±5° of Power Lever Angle. \3\ Ground. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Simultaneous recording for all engines. A 5° tolerance applies against airplane data and between engines. May be Snapshot Test.

(8) \1\ Brake Pedal Position vs. Force/ \2\ ±5 lb (2.224 daN) or 10%. ±10% or 150 psi (1033 kPa) brake hydraulic pressure. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Simulator computer output results may be used to show compliance. Relate hydraulic system pressure to pedal position in a ground static test.

b. DYNAMIC CONTROL CHECKS: Column, wheel, and pedal position vs. force or time shall be measured at the control. An alternate method acceptable to the ECAA in lieu of the test fixture at the controls is to instrument the simulator in an equivalent manner to the flight test airplane. The force and position data from this instrumentation can be directly recorded and matched to the airplane data. Such a permanent installation would eliminate the need for installation of external devices.

(1) \1\ Pitch Control. \2\ ±10% of time for first zero crossing, and ±10(n + 1)% of period thereafter.. ±10% amplitude of first overshoot.. ±20% of amplitude of 2nd and subsequent overshoots greater than 5% of initial displacement.. ±1 overshoot.. \3\ Takeoff, Cruise, Landing. \4\ C = IR. D = IR. \5\ Data should be normal control displacement in both directions. Approximately 25% to 50% of full throw. n is the sequential period of a full cycle of oscillation. Refer to paragraph 3 this appendix.

(2) \1\ Roll Control. \2\ Same as (1) above.. \3\ Takeoff, Cruise, Landing. \4\ C = IR. D = IR. \5\ Data should be normal control displacement. Approximately 25% to 50% of full throw.

(3) \1\ Yaw Control. \2\ Same as (1) above.. \3\ Takeoff, Cruise, Landing. \4\ C = IR. D = IR. \5\ Data should be normal control displacement. Approximately 25% to 50% of full throw.

c. LONGITUDINAL

(1) \1\ Power Change Dynamics. \2\ ±3 knots Airspeed. ±100 feet (30 meters) Altitude.±20% or ±1.5° Pitch . \3\ Approach to Go-Around. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Wing flaps should remain in the approach position. Time history of uncontrolled free response for time increment from 5 seconds before the initiation of the configuration change to 15 seconds after completion of the configuration change.

(2) \1\ Flap/Slat Change Dynamics. \2\ ±3 knots Airspeed. ±100 feet (30 meters) Altitude. ±20% or; ±1.5° Pitch. \3\ Retraction, After Takeoff.. Extension, Approach to Landing. \4\ A = IR. B = IR. C =. IR. D = IR. \5\ Time history of uncontrolled free response for time increment from 5 seconds before the initiation of the configuration change to 15 seconds after completion of the configuration change.

(3) \1\ Spoiler/Speedbrake Change Dynamics. \2\ ±3 knots Airspeed. ±100 feet (30 meters) Altitude. ±20% or ±1.5° Pitch. \3\ Cruise and Approach. \4\ A = IR. B = IR/ C = IR. D = IR. \5\ Time history of uncontrolled free response for time

increment from 5 seconds before the initiation of the configuration change to 15 seconds after the completion of the configuration change.

(4) \1\ Gear Change Dynamics. \2\ ±3 knots Airspeed. ±100 feet (30 meters) Altitude. ±20% or ±1.5° Pitch. \3\ Takeoff to Second Segment Climb, Approach to Landing. \4\ A = IR. B = IR. C = IR. D =. IR. \5\ Time history of uncontrolled free response for time increment of 5 seconds before the initiation of the configuration change to 15 seconds after the completion of the configuration change.

(5) \1\ Gear and Flap/Slat Operating Times. \2\ ±1 second or 10% of Time. \3\ Takeoff, Approach. \4\. A = IR. B = IR. C = IR. D = IR. \5\ Normal and alternate flaps, extension and retraction. Normal gear, extension and retraction. Alternate gear, extension only.

(6) \1\ Longitudinal Trim. \2\ ±1° Pitch Control (Stabilizer and Elevator). ±1° Pitch Angle. ±5% Net. Thrust or Equivalent. \3\ Cruise, Approach, Landing. \4\ A = IR. B = IR. C = IR. D = IR. \5\ May be Snapshot Tests.

(7) \1\ Longitudinal Maneuvering Stability (Stick Force/g). \2\ ±5 lbs. (2.224 daN) or ±10% Column Force or Equivalent Surface. \3\ Cruise, Approach, Landing. \4\ A = IR. B = IR. C = IR. D = IR. \5\ May be series of Snapshot Tests. Force or surface deflection must be in correct direction. Approximately 20°, 30°, and 45° bank angle should be presented.

(8) \1\ Longitudinal Static Stability. \2\ ±5 lbs. (2.224 daN) or ±10% Column Force or Equivalent. Surface. \3\ Approach. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Data for at least 2 speeds above and 2 speeds below trim speed. May be a series of Snapshot Tests.

(9) \1\ Stick Shaker, Airframe Buffet, Stall Speeds. \2\ ±3 knots Airspeed. ±2° Bank for speeds higher. than stick shaker or initial buffet. \3\ Second Segment Climb and Approach or Landing. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Stall Warning Signal should be recorded and must occur in the proper relation to stall.

(10) \1\ Phugoid Dynamics. \2\ ±10% of Period. 10% of Time to 1/2 or Double Amplitude or ±.02 of Damping Ratio. \3\ Cruise. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Test should include 3 full cycles (6 overshoots after input completed) or that sufficient to determine time to 1/2 amplitude whichever is less.

(11) \1\ Short Period Dynamics. \2\ ±1.5° Pitch or ±2°/second Pitch Rate. ±.10g Normal Acceleration. \3\ Cruise. \4\ B = IR. C = IR. D = IR

d. LATERAL-DIRECTIONAL

(1) \1\ Minimum Control Speed, Air (Vmca), per Applicable Airworthiness Standard, OR, Low Speed Engine Inoperative Handling Characteristics in Air. \2\ ±3 knots Airspeed. \3\ Takeoff or Landing (Whichever is most critical in airplane). \4\ A = IR. B = IR. C = IR. D = IR. \5\ Vmca may be defined by a performance or control limit which prevents demonstration of Vmca in the conventional manner.

(2) \1\ Roll Response (Rate). \2\ ±10% or ±2°/second Roll Rate. \3\ Cruise and Approach or Landing. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Test with normal wheel deflection (about 30%).

(3) \1\ Roll Response to Roll Controller Step Input. \2\ ±10% or ±2°/second Roll Rate. \3\ Approach or. Landing. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Roll rate response.

(4) \1\ Spiral Stability. \2\ Correct Trend, ±2° Bank or ±10% in 20 Seconds. \3\ Cruise. \4\ A = IR. B = IR. C = IR. D = IR. \5\ Airplane data averaged from multiple tests may be used. Test for both directions.

(5) \1\ Engine Inoperative Trim. \2\ ±1° Rudder Angle or ±1° Tab Angle or Equivalent Pedal. ±2°. Sideslip Angle. \3\ Second Segment and Approach or Landing. \4\ A = IR. B = IR. C = IR. D = IR. \5\ May be Snapshot Tests.

(6) \1\ Rudder Response. \2\ ±2°/second or ±10% Yaw Rate. \3\ Approach or Landing. \4\ A = IR. B =. IR. C = IR. D = IR. \5\ Test with stability augmentation ON and OFF. Rudder step input of approximately 25% rudder pedal throw.

(7) \1\ Dutch Roll, Yaw Damper OFF. \2\ ±0.5 seconds or ±10% of Period.. ±10% of Time to 1/2 or. Double Amplitude or ±.02 of Damping Ratio.. ±20% or ±1 second of Time Difference Between. Peaks of Bank and Sideslip.. \3\ Cruise

and Approach or Landing. \4\ B = IR. C = IR. D = IR. \5\ Test for at least 6 cycles with stability augmentation OFF.

(8) \1\ Steady-State Sideslip. \2\ For a given rudder position ±2° Bank, ±1° Sideslip, ±10% or ±2°. Aileron, ±10% or ±5° Spoiler or Equivalent Wheel Position. \3\ Approach or Landing. \4\ A = IR. B. = IR. C = IR. D = IR. \5\ May be a series of Snapshot Tests.

e. LANDINGS

(1) \1\ Normal Landing. \2\ ±3 knots Airspeed, ±1.5° Pitch,±1.5° Angle-of-Attack., ±10% Altitude or ±10 feet (3 meters). \3\ Landing. \4\ B = IR. C = IR. D = IR. \5\ Test from a minimum of 200 feet (61 meters) AGL to Nose Wheel Touchdown. De-rotation may be shown as a separate segment from the time of main gear touchdown.

(2) \1\ Crosswind Landing. \2\ ±3 knots Airspeed. ±1.5° Pitch. ±1.5° Angle-of-Attack. ±10% Altitude or ±10 feet (3 meters). ±2° Bank Angle. ±2° Sideslip Angle or Yaw Angle. \3\ Landing. \4\ B = IR. C = IR. D = IR. \5\ Test from a minimum of 200 feet (61 meters) AGL to Nose Wheel Touchdown and rollout to 60 knots. Use near maximum landing weight with same Relative Wind Profile as aircraft test.

(3) \1\ One Engine Inoperative Landing. \2\ ±3 knots Airspeed. ±1.5° Pitch. ±1.5° Angle-of-Attack. ±10% Altitude or ±10 feet (3 meters). ±2° Bank Angle. ±2° Sideslip Angle or Yaw Angle. \3\. Landing. \4\ B = IR. C = IR. D = IR. \5\ Test from a minimum of 200 feet (61 meters) AGL to Nose Wheel Touchdown.

(4) \1\ Directional Control (Rudder Effectiveness) With Reverse Thrust, Symmetric and Asymmetric. \2\ ±5 knots Airspeed. \3\ Landing. \4\ B = IR. C = IR. D = IR. \5\ Airplane test data required, however, airplane manufacturer's engineering simulator data may be used for reference data as last resort. Airplanes with demonstrated minimum speed for rudder effectiveness ±5 knots. Others, test to verify simulator meets conditions demonstrated by airplane manufacturer.

f. GROUND EFFECT

\1\ A Test to Demonstrate Longitudinal Ground Effect. \2\ ±1° Elevator or Stabilizer Angle. ±5%. Net Thrust or Equivalent. ±1° Angle-of-Attack. ±10% Height/Altitude or ±5 Feet (1.5 meters). ±3. knots Airspeed. ±1° Pitch Attitude. \3\ Landing. \4\ B = IR. C = IR. D = IR. \5\ See paragraph 4, this appendix. A rationale must be provided with justification of results.

## 3. MOTION SYSTEM

a. \1\ Frequency Response. \2\ As specified by operator for simulator acceptance.. \4\ A = IR. B = IR. C. = IR. D = IR. \5\ Appropriate test to demonstrate Frequency Response required.

b. \1\ Leg Balance. \2\ As specified by operator for simulator acceptance.. \4\ A = IR. B = IR. C = IR. D. = IR. \5\ Appropriate test to demonstrate Leg Balance required.

c. \1\ Turn Around Check. \2\ As specified by operator for simulator acceptance.. \4\ A = IR. B = IR. C. = IR. D = IR. \5\ Appropriate test to demonstrate Smooth Turn Around required.

d. \1\ Characteristic Buffet Motions. \2\ See Appendix 1, paragraph 3.f.; \4\ D = IR. \5\ Compliance statement required. Test required.

## 4. VISUAL SYSTEM - (Note: Refer to Appendix 3 for additional visual tests).

a. \1\ Visual Ground Segment (VGS). \2\ ±20%. Threshold lights must be visible if they are in the visual segment. (See example in Comments.). \3\ Landing. Static at 100 feet (30 meters) Wheel Height Above Touchdown Zone on Glideslope. Runway Visual Range = 1200 feet or 350 meters.. \4\ A = IR. B = IR. C = IR. D = IR. \5\ The ATG should indicate the source of data, that is, ILS G/S antenna location, pilot eye reference point, cockpit cutoff angle, etc. used to make visual ground segment scene content calculations.

Tolerance Example: If the calculated VGS for the airplane is 840 feet, the 20% tolerance of 168 feet may be applied at the near or far end of the simulator VGS or may be split between both as long as the total of 168 feet is not exceeded.

b. \1\ Visual System Color. \2\ Demonstration Model. \4\ C = IR. D = IR.

c. \1\ Visual RVR Calibration. \2\ Demonstration Model. \4\ C = IR. D = IR

d. \1\ Visual Display Focus and Intensity. \2\ Demonstration Model. \4\ C = IR. D = IR.

e,\1\ Visual Attitude vs. Simulator Attitude Indicator (Pitch and Roll of Horizon). \2\ Demonstration Model. \4\ C = IR. D = IR

f. \1\ Demonstrate 10 Levels of Occulting Through Each Channel of System. \2\ Demonstration Model. \4\ C = IR. D = IR. \5\ May be requested for recurrent evaluation.

## 5. SIMULATOR SYSTEMS

VISUAL, MOTION, AND COCKPIT INSTRUMENT RESPONSE.

a. Visual, Motion, and Instrument Systems response to an abrupt pilot controller input, compared to airplane response for similar input.. 2\ 150 milliseconds or less after airplane response.. \3\ Takeoff, Cruise Approach or Landing. \4\ C = IR. D = IR. \2\ 300 milliseconds or less after airplane response. \3\ Takeoff, Cruise,. Approach or Landing. \4\ A = IR. B = IR. \5\ One test is required in each axis (pitch, roll, and yaw) for each of the 3 conditions compared to airplane data for a similar input. (Total 9 tests.)

Visual change may start before motion response, but motion acceleration must occur before completion of visual scan of first video field containing different information.

OR: \1\ Transport Delay. \2\ 150 milliseconds or less after control movement.. \3\ Pitch, Roll, Yaw. \4\. C = IR. D = IR. \5\ One test is required in each axis. (Total 3 tests.). \2\ 300 milliseconds or less after. control movement.. \3\ Pitch, Roll, Yaw. \4\ A = IR. B = IR. \5\ See Appendix 1, Item 2.v.

b. SOUND.

(1) Realistic amplitude and frequency of cockpit noises and sounds, including precipitation. static, and engine and airframe sounds. The sounds shall be coordinated with the weather representations required in Part121, Appendix H, Phase III (Level D), Visual Requirement No. 3.. \4\ D = IR. \5\ Test results must show a comparison of the amplitude and frequency content of the sounds that originate from the airplane or airplane systems.

c. DIAGNOSTIC TESTING

(1) A means for quickly and effectively testing simulator programming and hardware. This could include an automated system which could be used for conducting at least a portion of the tests in the ATG.. \4\ C = IR. D = IR.

(2) Self-testing of simulator hardware and programming to determine compliance with Levels B, C, and D Simulator Requirements.. \4\ D = IR

(3) Diagnostic analysis as prescribed in Part121, Appendix H, Phase III (Level D) Simulator Requirement No. 5. \4\ D = IR

## 3. CONTROL DYNAMICS.

The characteristics of an airplane flight control system have a major effect on the handling qualities. A significant consideration in pilot acceptability of an airplane is the "feel" provided through the cockpit controls. Considerable effort is expended on airplane feel system design in order to deliver a system with which pilots will be comfortable and consider the airplane desirable to fly. In order for a simulator to be representative, it too must present the pilot with the proper feel; that of the respective airplane. This fact is recognized in Part121, Appendix H, Phase II (Level C) Simulator Requirement 10, which states: "Aircraft control feel dynamics shall duplicate the airplane simulated. This shall be determined by comparing a recording of the control feel dynamics of the simulator to airplane measurements in the takeoff, cruise, and landing configuration."

Recordings such as free response to an impulse or step function are classically used to estimate the dynamic properties of electromechanical systems. In any case, it is only possible to estimate the dynamic properties as a result of only being able to estimate true inputs and responses. Therefore, it is imperative that the best possible data be collected since close matching of the simulator control loading system to the airplane systems is essential. The required control feel dynamic tests dictated by Part121, Appendix H, are described in 2.b. of the Table of Validation Tests of this section.

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

For airplanes 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 airplanes, takeoff, cruise, and landing configurations have like effects. Thus, one may suffice for another. If either or both considerations apply, engineering validation or airplane manufacturer rationale must be submitted as justification for ground tests or for eliminating a configuration. For simulators requiring static and dynamic tests at the controls, special test fixtures will not be required during initial and upgrade evaluations if the operator's ATG shows both test fixture results and the results of an alternative approach, such as computer plots which were produced concurrently and show satisfactory agreement. Repeat of the alternative method during the initial evaluation would then satisfy this test requirement.

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

b. For Levels C and D Simulators. Tests to verify that control feel dynamics represent the airplane must show that the dynamic damping cycles (free response of the control) match that of the airplane within specified tolerances. The method of evaluating the response and the tolerance to be applied are described below for the under-damped and critically damped cases.

(1) Under-damped 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 airplane 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 percent of the total initial displacement should be considered significant. The residual band, labeled T(A sub d) on Figure 1 is ±5 percent of the initial displacement amplitude A sub d from the steady-state value of the oscillation. Oscillations within the residual band are considered insignificant. When comparing simulator data to airplane data, the process should begin by overlaying or aligning the simulator and airplane steady-state values and then comparing amplitudes of oscillation peaks, the time of the first zero crossing, and individual periods of oscillation. The simulator should show the same number of significant overshoots to within one when compared against the airplane data. This procedure for evaluating the response is illustrated in Figure 1.

(2) Critically Damped and Over-damped Response. Due to the nature of critically damped responses (no overshoots), the time to reach 90 percent of the steady-state (neutral point) value should be the same as the airplane within ±10 percent. The simulator response should be critically damped also. Figure 2 illustrates the procedure.

Tolerances

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

T(P sub o) ±10% of (P sub 0)
T(P sub 1) ±20% of (P sub 1)
T(P sub 2) ±30% of (P sub 2)
T(P sub n) ±10%(n + 1)% of (P sub n)

T(A sub n) ±10% of (A sub 1), ±20% of Subsequent Peaks

T(A sub d) ±5% of (A sub d) = Residual Band Overshoots ±1

c. Alternative Method for Control Dynamics. One airplane manufacturer has proposed, and the ECAA accepts, an alternative means for dealing with control dynamics. The method applies to airplanes with hydraulically powered flight controls and artificial feel systems. Instead of free response measurements, the system would be validated by measurements of control force and rate of movement.

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

(1) 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.

(2) Slow Dynamic Test - Achieve a full sweep in approximately 10 seconds.

(3) Fast Dynamic Test - Achieve a full sweep in approximately 4 seconds.

NOTE: Dynamic sweeps may be limited to forces not exceeding 100 pounds.

Tolerances

(4 ) Aic Test - Items 2.a.(1)(2) and (3) of this appendix.

(5 ) Nmic Test - 2 lb or 10 percent on dynamic increment above static test.

The ECAA is open to alternative means such as the one described above. Such alternatives must, 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 airplanes with reversible control systems. Hence, each case must be considered on its own merit on an ad hoc basis. Should the ECAA find that alternative methods do not result in satisfactory simulator performance, then more conventionally accepted methods must be used.

## 4. GROUND EFFECT.

During landing and takeoff, airplanes operate for brief time intervals close to the ground. The presence of the ground significantly modifies the air flow past the airplane and, therefore, changes the aerodynamic characteristics. The close proximity of the ground imposes a barrier which inhibits the downward flow normally associated with the production of lift. The downwash is a function of height with the effects usually considered to be negligible above a height of approximately one wingspan. There are three main effects of the reduced downwash:

a. A reduction in downwash angle at the tail for a conventional configuration.

b. An increase in both wing and tail lift because of changes in the relationship of lift coefficient to angle-of-attack (increase in lift curve slope).

c. A reduction in the induced drag.

Relative to out-of-ground effect flight (at a given angle-of-attack), these effects result in higher lift in ground effect and less power required for level flight. Because of the associated effects on stability, they also cause significant changes in elevator (or stabilizer) angle to trim and stick (column) forces required to maintain a given lift coefficient in level flight near the ground.

For a simulator to be used for takeoff and in particularly landing credit, it must faithfully reproduce the aerodynamic changes which occur in ground effect. The parameters chosen for simulator validation must obviously be indicative of these changes. The primary validation parameters for longitudinal characteristics in ground effect are:

1. Elevator or stabilizer angle to trim.
2. Power (thrust) required for level flight (PLF).
3. Angle-of-attack for a given lift coefficient.
4. Height/altitude.
5. Airspeed.

This listing of parameters assumes that ground effect data is acquired by tests during "flybys" at several altitudes in and out of ground effect. The test altitudes should, as a minimum, be at 10 percent, 30 percent, and 70 percent of the airplane wingspan and one altitude out of ground effect; such as, 150 percent of wingspan. Level flybys are required for Level D, but not for Level C and Level B. They are, however, acceptable for all levels.

If, in lieu of the level flyby method for Levels B and C, other methods such as shallow glidepath approaches to the ground maintaining a chosen parameter constant are proposed, then additional validation parameters are important. For example, if constant attitude shallow approaches are chosen as the test maneuver, pitch attitude, and flight path angle are additional necessary validation parameters. The selection of the test methods and procedures to validate ground effect is at the option of the organization performing the flight tests; however, rationale must be provided to conclude that the tests performed do indeed validate the ground effect model.

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

Elevator or Stabilator Angle ±1°
Power for Level Flight (PLF) ±5%
Angle-of-Attack ±1
Altitude/Height ±10% or ±5 feet (1.5 m)
Airspeed ±3 Knots
Pitch Attitude ±1°

The lateral-directional characteristics are also altered by ground effect. Because of the above mentioned changes in lift curve slope, roll damping, as an example, is affected. The change in roll damping will affect other dynamic modes usually evaluated for simulator validation. In fact, Dutch roll dynamics, spiral stability, and roll rate for a given lateral control input are altered by ground effect. Steady heading sideslips will also be affected. These effects must be accounted for in the simulator modeling. Several tests such as "crosswind landing," "one engine inoperative landing," and "engine failure on takeoff" serve to validate lateral-directional ground effect since portions of them are accomplished while transiting altitudes at which ground effect is an important factor.

# APPENDIX 3.
# FUNCTIONS AND SUBJECTIVE TESTS

## 1. DISCUSSION.

Accurate replication of airplane systems functions will be checked at each flight crewmember position by an ECAA Simulator Evaluation Specialist. This includes procedures using the operator's approved manuals and checklists. Handling qualities, performance, and simulator systems operation will be subjectively assessed by an ECAA Simulator Evaluation Specialist qualified in the respective airplane.

At the request of an operator, the Simulator Evaluation Specialist may assess the simulator for a special aspect of an operator's training program during the functions and subjective portion of a recurrent evaluation. Such an assessment may include a portion of a LOFT scenario or special emphasis items in the operator's training program. Unless directly related to a requirement for the current qualification level, the results of such an evaluation would not affect the simulator's current status.

Operational principal navigation systems including inertial navigation systems, OMEGA, or other long range systems, and the associated electronic display systems will be evaluated if installed. The Simulator Evaluation Specialist will include in his report to the operator the effect of the system operation and system limitations.

## 2. TEST REQUIREMENTS.

The ground and flight tests and other checks required for qualification are listed in the Table of Functions and Subjective Tests. The table includes maneuvers and procedures to assure that the simulator functions and performs appropriately for use in pilot training and checking in the maneuvers and procedures delineated in Part 61 and Part 121, Appendices E and F. It also contains tests to assure compliance with Part 121, Appendix H, and other regulatory provisions. Maneuvers and procedures are included to address some features of advanced technology airplanes and innovative training programs. For example, "high angle-of-attack maneuvering" is included to provide an alternative to "approach to stalls." Such an alternative is necessary for airplanes employing flight envelope limiting technology. The portion of the table addressing pilot functions and maneuvers is divided by flight phases. Visual systems tests are listed separately as are special effects.

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

## TABLE OF FUNCTIONS AND SUBJECTIVE TESTS SIMULATOR LEVEL

-----------------------------------------------------------------------

KEY: (SIMULATOR LEVEL - A, B, C, D)

-----------------------------------------------------------------------

### 1. FUNCTIONS AND MANEUVERS

a. PREPARATION FOR FLIGHT

(1) (A, B, C, D) Preflight. Accomplish a functions check of all switches, indicators, systems, and equipment at all crewmembers' and instructors' stations and determine that the cockpit design and functions are identical to that of the airplane simulated.

b. SURFACE OPERATIONS (PRETAKEOFF)

(1) (A, B, C, D) Engine start.
(i) Normal start.
(ii) Alternate start procedures.
(iii) Abnormal starts and shutdowns (hot start, hung start, etc.).

(2) (A, B, C) Pushback/powerback.

(3) (A, B, C, D) Taxi.
(i) Thrust response.
(ii) Power lever friction.
(iii) Ground handling.
(iv) Nose wheel scuffing.
(v) Brake operation (normal and alternate/emergency).
(vi) Brake fade (if applicable).
(vii) Other.

c. TAKEOFF

(1) (A, B, C, D) Normal.
(i) Engine parameter relationships.
(ii) Acceleration characteristics.
(iii) Nose wheel and rubber steering.
(iv) Crosswind (maximum demonstrated).
(v) Special performance.
(vi) Instrument takeoff.
(vii) Landing gear, wing flap, leading edge device operation.
(viii) Other.

(2) (A, B, C, D) Abnormal/Emergency.
(i) Rejected.
(ii) Rejected special performance.
(iii) With failure of most critical engine at most critical point along takeoff path (continued takeoff).
(iv) With windshear.
(v) Flight control system failure modes.
(vi) Other.

d. INFLIGHT OPERATION

(1) (A, B, C, D) Climb.
(i) Normal.
(ii) One engine inoperative.
(iii) Other.

(2) (A, B, C, D) Cruise.
(i) Performance characteristics (speed vs. power).
(ii) Turns with/without spoilers (speedbrake) deployed.
(iii) High altitude handling.
(iv) High speed handling.
(v) Mach tuck and trim, overspeed warning.
(vi) Normal and steep turns.
(vii) Performance turns.
(viii) Approach to stalls (stall warning, buffet, and g-break) cruise, takeoff, approach, and landing configuration.
(ix) High angle-of-attack maneuvers (cruise, takeoff, approach, and landing).
(x) In-flight engine shutdown and restart.
(xi) Maneuvering with one engine inoperative.
(xii) Specific flight characteristics.

Manual flight control reversion.
(xiv) Flight control system failure modes.
(xv) Other.
(3) (A, B, C, D) Descent.
(i) Normal.
(ii) Maximum rate.
(iii) Manual flight control reversion.
(iv) Flight control system failure modes.
(v) Other.
e. APPROACHES
(1) (A, B, C, D) Non-precision.
(i) Approach procedure(s), one or more of the following.
- NDB
- VOR, RNAV, TACAN
- DME ARC
- LOC/BC
- LDA, LOC, SDF
- ASR
(ii) Missed approach.
(iii) All engines operating.
(iv) One or more engines inoperative.
(2) (A, B, C, D) Precision.
(i) PAR.
(ii) ILS.
(A) Normal.
(B) Engine(s) inoperative.
(C) Category I published approach.
1 - Manually controlled with and without flight director to 100 feet (30 m) below CAT I minima.
2 - With crosswind (maximum demonstrated).
3 - With windshear.
(D) Category II published approach.
1 - Autocoupled, autothrottle, autoland.
2 - All engines operating missed approach.
(E) Category III published approach.
1 - With generator failure.
2 - With 10 knot tailwind.
3 - With 10 knot crosswind.
4 - One engine inoperative.
(iii) Missed approach.
(A) All engines operating.
(B) One or more engines inoperative.
(3) (A, B, C, D) Visual.
(i) Abnormal wing flaps/slats.
(ii) Without glideslope guidance.
f. VISUAL SEGMENT AND LANDING
(1) Normal.
(i) (B, C, D) Crosswind (maximum demonstrated).
(ii) (Reserved) From VFR traffic pattern.
(iii) (B, C, D) From non-precision approach.
(iv) (A, B, C, D) From precision approach.
(v) (A, B, C, D) From circling approach.
NOTE: Simulators with visual systems which permit completing a circling approach without violating ECAR Section 91.175(e) may be approved for that particular circling approach procedure.
(2) (A, B, C, D) Abnormal/emergency.
(i) Engine(s) inoperative.
(ii) Rejected.
(iii) With windshear.
(iv) With standby (minimum electrical/hydraulic) power.
(v) With longitudinal trim malfunction.

(vi) With lateral-directional trim malfunction.
(vii) With loss of flight control power (manual reversion).
(viii) With worst case failure of flight control system (most significant degradation of fly-by-wire system which is not extremely improbable).
(ix) Other flight control system failure modes as dictated by training program.
(x) Other.

g. SURFACE OPERATIONS (POST LANDING)
(1) (B, C, D) Landing roll and taxi.
(i) Spoiler operation.
(ii) Reverse thrust operation.
(iii) Directional control and ground handling, both with and without reverse thrust.
(iv) Reduction of rudder effectiveness with increased reverse thrust (rear pod mounted engines).
(v) Brake and antiskid operation with dry, wet, and icy conditions.
(vi) Brake operation.
(vii) Other.

h. ANY FLIGHT PHASE
(1) (A, B, C, D) Airplane and powerplant systems operation.
(i) Air conditioning.
(ii) Anti-icing/deicing.
(iii) Auxiliary powerplant.
(iv) Communications.
(v) Electrical.
(vi) Fire detection and suppression.
(vii) Flaps/slats/speedbrakes
(viii) Flight controls.
(ix) Fuel and oil.
(x) Hydraulic.
(xi) Landing gear.
(xii) Oxygen.
(xiii) Pneumatic.
(xiv) Powerplant.
(xv) Pressurization.
(2) (A, B, C, D) Flight management and guidance systems.
(i) Airborne radar.
(ii) Automatic landing aids.
(iii) Autopilot.
(iv) Collision avoidance system.
(v) Flight control computers.
(vi) Flight data displays.
(vii) Flight management computers.
(viii) Head-up displays.
(ix) Navigation systems.
(x) Stall warning/avoidance.
(xi) Stability and control augmentation.
(xii) Windshear avoidance equipment.
(3) (A, B, C, D) Airborne procedures.
(i) Holding.
(ii) (C, D) Air hazard avoidance.
(iii) Windshear.
(4) (A, B, C, D) Engine Shutdown and parking.
(i) Engine and systems operation.
(ii) Parking brake operation.
(5) Other.

**2. VISUAL SYSTEM**

a. (A, B, C, D) Accurate portrayal of environment relating to simulator attitudes.
b. (A, B, C, D) The distances at which runway features are visible should not be less than those listed below. Distances are measured from runway threshold to an airplane aligned with the runway on an extended 3-degree glideslope.

(1) Runway definition, strobe lights, approach lights, runway edge white lights and VASI lights from 5 statute miles (8 kilometers) of the runway threshold.
(2) Runway centerline lights and taxiway definition from 3 statute miles (4.8 kilometers).
(3) Threshold lights and touchdown zone lights from 2 statute miles (3.2 kilometers).
(4) Runway markings within range of landing lights for night scenes; as required by 3 arc-minutes resolution on day scenes.

c. (A, B, C, D) Representative airport scene content including:
(1) Airport runways and taxiways.
(2) Runway definition.
(i) Runway surface and markings.
(ii) Lighting for the runway in use including runway edge and centerline lighting, touchdown zone, VASI, and approach lighting of appropriate colors.
(iii) Taxiway lights.

d. (A, B, C, D) Operational landing lights.

e. (A, B, C, D) Instructor controls of:
(1) Cloudbase.
(2) Visibility in statute miles (km) and RVR in feet (meters).
(3) Airport selection.
(4) Airport lighting.

f. (A, B, C, D) Visual system compatibility with aerodynamic programming.

g. (B, C, D) Visual cues to assess sink rates and depth perception during landings.
(1) Surface on taxiways and ramps.
(2) Terrain features.

h. (C, D) Dusk and night visual scene capability.

i. (C, D) Minimum of three specific airport scenes.
(1) Surfaces on runways, taxiways, and ramps.
(2) Lighting of appropriate color for all runways including runway edge, centerline, VASI, and approach lighting for the runway in use.
(3) Airport taxiway lighting.
(4) Ramps and terminal buildings which correspond to an operator's Line Oriented Flight Training and Line Oriented Simulator scenarios.

j. (C, D) General terrain characteristics and significant landmarks.

k. (C, D) At and below an altitude of 2,000 feet (610 m.) height above the airport and within a radius of 10 miles (16 kilometers) from the airport, weather representations, including the following:
(1) Variable cloud density.
(2) Partial obscuration of ground scenes; the effect of a scattered to broken cloud deck.
(3) Gradual breakout.
(4) Patchy fog.
(5) The effect of fog on airport lighting.

l. (C, D) A capability to present ground and air hazards such as another airplane crossing the active runway or converging airborne traffic.

m. (D) Operational visual scenes which portray representative physical relationships known to cause landing illusions such as short runways, landing approaches over water, uphill or downhill runways, rising terrain on the approach path, and unique topographic features.

n. (D) Special weather representations of light, medium, and heavy precipitation near a thunderstorm on takeoff, approach, and landings at and below an altitude of 2,000 feet (610 m.) above the airport surface and within a radius of 10 miles (16 kilometers) from the airport.

o. (D) Wet and snow covered runways including runway lighting reflections for wet, partially obscured lights for snow, or suitable alternative effects.

p. (D) Realistic color and directionality of airport lighting.

q. (D) Weather radar presentations in airplanes where radar information is presented on the pilot's navigation instruments. Radar returns should correlate to the visual scene.

r. (D) Freedom from apparent quantization (aliasing).

## 3. SPECIAL EFFECTS

a. (B, C, D) Runway rumble, oleo deflections, effects of groundspeed and uneven runway characteristics.
b. (B, C, D) Buffets on the ground due to spoiler/speedbrake extension and thrust reversal.
c. (B, C, D) Bumps after liftoff of nose and main gear.
d. (B, C, D) Buffet during extension and retraction of landing gear.
e. (B, C, D) Buffet in the air due to flap and spoiler/speedbrake extension and approach-to-stall buffet.
f. (B, C, D) Touchdown cues for main and nose gear.
g. (B, C, D) Nose wheel scuffing.
h. (B, C, D) Thrust effect with brakes set.
i. (C, D) Representative brake and tire failure dynamics (including antiskid) and decreased brake efficiency due to high brake temperatures based on airplane related data. These representations should be realistic enough to cause pilot identification of the problem and implementation of appropriate procedures. Simulator pitch, side loading, and directional control characteristics should be representative of the airplane.
j. (C, D) Sound of precipitation and significant airplane noises perceptible to the pilot during normal operations and the sound of a crash when the simulator is landed in excess of landing gear limitations. Significant airplane noises should include noises such as engine, flap, gear, and spoiler extension and retraction and thrust reversal to a comparable level as that found in the airplane. The sound of a crash should be related in some logical manner to landing in an unusual attitude or in excess of the structural gear limitations of the airplane.
k. (C, D) Effects of airframe icing.

# APPENDIX 4.
# EXAMPLES

## FIGURE 1. APPLICATION LETTER

Name, OPERATOR, _________________ (Operator)
Address

Dear Mr.____________:

______(Name)______ Airlines requests evaluation of our ______(Type)______ airplane simulator for Level ______ qualification. The ______(Name)______ simulator with ______(Name)______ visual system is fully defined on page ______ of the accompanying approval test guide (ATG). We have completed tests of the simulator and certify that it meets all applicable requirements of ECAR Section 121.407, Part121, Appendix H, and the guidance of EAC 121-1. Appropriate hardware and software configuration control procedures have been established. Our pilots have assessed the simulator and found that it conforms to the ______(Name)______ Airlines ______(Type)______ airplane cockpit configuration and that the simulated systems and subsystems function equivalently to those in the airplane. Our pilots have also assessed the performance and flying qualities of the simulator and find that it represents the respective airplane.
(Added comments as desired.)

Sincerely,

## FIGURE 2. EXAMPLE ATG COVER PAGE

OPERATOR NAME
OPERATOR ADDRESS

ECAA APPROVAL TEST GUIDE
(AIRPLANE MODEL)
(Type of Simulator)
(Simulator Identification Including Manufacturing, Serial Number, Visual System Used)
(Simulator Location)

ECAA Initial Evaluation
Date: ________________

__________(Operator Approval)___________ Date: _________

________________________________________ Date: _________
ECAA, Manager, National Simulator Program

# FIGURE 3. SIMULATOR INFORMATION PAGE EXAMPLE

OPERATOR
--------------------------

OPERATOR SIMULATOR CODE: BA707#1

AIRPLANE MODEL: Stratos BA707-320

AERODYNAMIC DATA REVISION: BA707-320 CPX-8D July 1988

ENGINE MODEL AND REVISION: CPX-8D-RPT-1 June 1988

FLIGHT CONTROLS DATA REVISION: BA707-320 May 1988

FLIGHT MANAGEMENT SYSTEM: Berry XP

SIMULATOR MODEL AND MANUFACTURER: MTD-707 Tinker

DATE OF SIMULATOR MANUFACTURE: 1988

SIMULATOR COMPUTER: CIA

VISUAL SYSTEM MODEL AND MANUFACTURER: ClearView P-T 5 Channel

VISUAL SYSTEM COMPUTER: LBM-6

MOTION SYSTEM: Tinker 6 DOF

# APPENDIX 5.
# WINDSHEAR QUALIFICATION

## 1. APPLICABILITY.

This appendix applies to all simulators used to satisfy the training requirements of Part 121 pertaining to the certificate holder's approved low altitude windshear flight training program.

## 2. STATEMENT OF COMPLIANCE.

A statement of compliance is required to include the following:

a. Documents that the aerodynamic model is based on airplane data supplied by the airplane manufacturer, or other named source, and that any change to environmental wind parameters, including variances in those parameters for windshear conditions, once inserted for computation, should result in the correct simulated performance.

b. Examples where environmental wind parameters are currently evaluated in the simulator (that is, crosswind takeoff, crosswind approach, or crosswind landings, etc.).

## 3. QUALIFICATION BASIS.

The addition of windshear programming to a simulator in order to comply with the qualification for required windshear training does not change the original qualification basis of the simulator.

## 4. MODELS.

The windshear models installed in the simulator software that will be used for qualification evaluation must:

a. Provide cues necessary for recognition of the onset of a windshear phenomena and potential performance degradation that would require a pilot to initiate recovery procedures. The cues must include one or more of the following, as may be appropriate:
   (1) Rapid airspeed change of at least ±15 knots.
   (2) Stagnation of airspeed during the takeoff roll.
   (3) Rapid vertical speed change of at least ±500 feet per minute.
   (4) Rapid pitch change of at least ±5 degrees.

b. b. Be adjustable in intensity (or other parameter to achieve the desired effect) so that after encountering and recognizing the windshear, and with the application of recommended procedures for escape from such a windshear, the following results may be achieved:
   (1) The performance capability of the simulated airplane permits the pilot to maintain a satisfactory flight path.
   (2) The performance capability of the simulated airplane does not permit the pilot to maintain a satisfactory flight path (crash).

c. Be available for use in the approved windshear flight training program. The means used to accomplish the "nonsurvivable" scenario of paragraph 4b(2), which involve operational elements of the simulated airplane, must reflect parameters which fall within the dispatch limitations of the airplane.

## 5. TESTS.

a. The operator should identify two of the required training windshear models (one takeoff and one approach) to be demonstrated for Approval Test Guide (ATG) purposes and should define the wind components of these two models for the survivable scenario. This definition should be presented in graphical format so that all components of the windshear are shown, including initiation point, variance in magnitude, and either time or distance correlation as may be appropriate. The simulator must be operated at the same gross weight, airplane configuration, and initial airspeed in both of the following situations for the two models selected (total of four tests):
   (1) Through calm air.
   (2) Through the selected survivable windshear.

b. In each of these four situations, at an "initiation point" (that point being where the onset of windshear conditions is, or would have been recognized, depending on the test being run), the recommended procedures for windshear recovery shall be applied, and the results shall be recorded, as specified in paragraph 6. These recordings shall be made without the presence of programmed random turbulence and, for the purposes of this testing, it is recommended, although not required, that the simulator be flown by means of the simulator's autodrive function (for those simulators that have autodrive capability) during the tests. Turbulence which results from the windshear model is to be expected, and no attempt may be made to neutralize turbulence from this source.

## 6. RECORDING PARAMETERS.

a. In each of the four ATG cases, an electronic recording (time history) must be made of the following parameters:

(1) Indicated or Calibrated Airspeed.
(2) Indicated Vertical Speed.
(3) Pitch Attitude.
(4) Indicated or Radio Altitude.
(5) Angle-of-Attack.
(6) Elevator Position.

b. These recordings shall be initiated at least 10 seconds prior to the initiation point and continued until recovery is complete or ground contact is made. For those simulators not capable of electronic recording of the above parameters, video recordings which have been cross-plotted into a time history format will be considered an acceptable means of data presentation. If data of sufficient resolution for elevator position is not obtainable using this method of video cross-plotting, then stick position may be used. Special, temporary instrumentation readout installations may be required to record these parameters on video tape.

## 7. EQUIPMENT INSTALLATION.

For those simulators where windshear warning, caution, or guidance hardware is not provided as original equipment with the airplane, and, therefore, subsequently added to the airplane and simulator, a statement of compliance is required stating that the simulation of the added simulator hardware and/or software, including associated cockpit displays and annunciations, functions the same or equivalent to the system(s) installed in the airplane. This statement shall be supported by a block diagram describing the input and output signal flow and comparing it to the airplane configuration.

## 8. APPROVAL TEST GUIDE (ATG).

a. The operator must develop the statement of compliance, accomplish the performance determination and recording, and forward the resulting information to the ECAA

When it is received and accepted, the ECAA will return the package to the operator with instructions to include the information in the ATG.

b. The simulator will be scheduled for an evaluation in accordance with normal procedures. Use of recurrent evaluation schedules will be used to the maximum extent possible.

c. During the on-site evaluation, the evaluator should ask the operator to run the performance tests and record the results. The results of these on-site tests will be compared to those results previously approved and placed in the ATG.

d. ATGs for new or upgraded simulators shall contain or reference the information described in paragraphs 2, 4, 5, 6, and 7 of this appendix as may be appropriate for the simulator.

## 9. FUNCTIONAL EVALUATION.

A simulator evaluation specialist must fly the simulator in at least two of the available windshear scenarios to evaluate subjectively the performance of the simulator as it encounters the programmed windshear conditions according to the following:

a. One scenario will include parameters that enable the pilot to maintain a satisfactory flight path.

b. One scenario will include parameters that will not enable the pilot to maintain a satisfactory flight path.

c. Other scenarios may be examined at the discretion of the simulator evaluation specialist.

# SUBPART B
# Flight Training Device Qualification

## 1. PURPOSE.

This Subpart provides an acceptable means, but not the only means, of ensuring compliance with the Egyptian Civil Aviation Regulations (ECAR) regarding the evaluation and qualification of all training devices.

## 5. INTRODUCTION.

a. The primary objective of flight training is to provide a means for flight crewmembers to acquire the skills and knowledge necessary to perform to a desired safe standard. Flight simulation provides an effective, viable environment for the instruction, demonstration, and practice of the maneuvers and procedures (called training events) pertinent to a particular airplane and crewmember position. Successful completion of flight training is validated by appropriate testing, called checking events.

b. There are seven levels of flight training devices, Level 1 through Level 7. Level 1 is currently reserved. Levels 2 and 3 are generic in that they are representative of no specific airplane cockpit and do not require reference to a specific airplane. Levels 4 through 7 represent a specific cockpit for the airplane represented. Within the generic or specific category, each higher level of flight training device is progressively more complex. Because of the increase in complexity and more demanding standards when progressing from Level 2 to Level 7, there is a continuum of technical definition across those levels. Above the seven levels of flight training devices there are four levels of simulators which are defined in Subpart A.

c. In addition to those flight training devices meeting the prescribed criteria contained in this Subpart for Level 6, this level will also be the category into which non-visual simulators (see Subpart A) will be placed for reference purposes. The placement of these unique simulators into Level 6 will not affect the standards or criteria of Level 6 flight training devices, nor will these flight training devices affect the standards or criteria of these simulators.

## 6. DEFINITIONS.

a. An Airplane Flight Training Device is a full scale replica of an airplane's instruments, equipment, panels, and controls in an open flight deck area or an enclosed airplane cockpit, including the assemblage of equipment and computer software programs necessary to represent the airplane in ground and flight conditions to the extent of the systems installed in the device; does not require a force (motion) cueing or visual system; is found to meet the criteria outlined in this EAC for a specific flight training device level; and in which any flight training event or flight checking event is accomplished.

b. Approval of the Flight Training Device is authorization by the operator for the device to be used for flight training events or flight checking events, as may be appropriate, based on its assigned qualification level and approved program.

c. Convertible Flight Training Device is a device in which hardware and software can be changed so that it becomes a replica of a different model, usually of the same type airplane.

d. Evaluation of the Flight Training Device is the process in which a Simulator Evaluation Specialist, compares the device and its performance, functions, and other characteristics to that of the replicated aircraft in accordance with acceptable methods, procedures, and standards.

e. Latency is the additional response time of the flight training device beyond that of the basic aircraft perceivable response time. This includes the update rate of the computer system combined with the time delays of the instruments, and, if installed, the time delays of the motion and visual systems.

f. Qualification of the flight training device is issued by the ECAA, for a specified level and is determined as a result of the evaluation of the device against the established criteria for that level.

g. A Replica (as used in the definition of a flight training device in this EAC) does not imply total duplication of all furnishings of the respective airplane. Items such as mounting panels, walls, ceilings, floors, coverings, windows, etc., must present only a representative appearance.

h. A Set of Airplanes, for purposes of this EAC, is a grouping of airplanes which all share similar performance (that is, normal airspeed/altitude operating envelope), similar handling characteristics, and the same number and type of propulsion system(s) (that is, turbojet engine, reciprocating engine, etc.).

i. Simulation Data are the various types of data used by the flight training device manufacturer and the operator to design, manufacture, and test a flight training device.

j. Simulator Evaluation Specialist is an ECAA technical specialist trained to evaluate simulators and flight training devices and to provide expertise on matters concerning aircraft simulation.

k. Transport Delay is the total flight training device system processing time required for an input signal from a pilot primary flight control until output response. It does not include the characteristic delay of the airplane simulated.

l. Upgrade, for the purpose of this Subpart, means the improvement or enhancement of a flight training device for the purpose of achieving a higher qualification level.

## 7. EVALUATION POLICY.

a. The methods, procedures, and standards defined in this Subpart constitute one means acceptable to the ECAA for the evaluation and qualification of flight training devices that are or may be used in the following:

(1) A training program approved under Parts 61, 63, 121 or 141;

(2) The course of conducting the pilot in command proficiency check required by Part61;

(3) The issuance of an airline transport pilot certificate or type rating in accordance with the provisions of Part61; or

(4) The satisfactory completion of the provisions of Parts 61or 141.

b. If an applicant chooses to utilize the approach described in this EAC, the applicant must adhere to all of the methods, procedures, and standards herein. However, this position is not intended to suppress innovation and imaginative development of flight training devices. Those flight training devices, which for one reason or another, do not, or cannot meet the provisions described in this Subpart for a specific level, may be evaluated on a case-by-case basis, especially when it appears that such a device could offer valuable or otherwise unique benefits. If an applicant desires to have a flight training device evaluated on this case-by-case basis, or desires to use a means other than that described in this Subpart to evaluate a flight training device, a proposal must be submitted to the ECAA for review and approval prior to the submittal of a detailed ATG.

c. It is the responsibility of the ECAA to evaluate and qualify all Level 6 and Level 7 flight training devices. The operator will evaluate and qualify Levels 2 - 5 flight training devices in accordance with the standards herein.

d. An operator may contract for use of a Levels 2 - 5 flight training device currently qualified by another operator, and need not obtain separate qualification of the device prior to obtaining ECAA approval to use the device in that operator's ECAA approved training program.

e. The flight training device must be assessed in those areas which are essential to accomplishing airman training and checking events. This includes aerodynamic responses and control checks, as well as performance in the takeoff, climb, cruise, descent, approach, and landing phases of flight. Crewmember station checks, instructor station functions checks, and certain additional requirements depending on the complexity of the device (that is, touch activated cathode ray tube instructor controls; automatic lesson plan operation; selected mode of operation for "fly-by-wire" airplanes; etc.) must be thoroughly assessed.

f. The intent is to evaluate flight training devices as objectively as possible. Pilot acceptance, however, is also an important consideration. Therefore, the device will be subjected to the validation tests listed in appendix 2 of this Subpart and the functions and subjective tests from appendix 3. These tests include a qualitative assessment by an ECAA pilot who is qualified in the respective airplane, or set of airplanes in the case of Levels 2 or 3. Validation tests are used to compare objectively flight training device data and airplane data (or other approved reference data) to assure that they agree within a specified tolerance. Functions tests provide a basis for evaluating flight training device capability to perform over a typical training period and to verify correct operation of the controls, instruments, and systems.

g. Tolerances, listed for parameters in appendix 2, should not be confused with design tolerances specified for flight training device manufacture. Tolerances for the parameters listed in appendix 2 are the maximum acceptable to the ECAA for validation of the device.

h. A convertible flight training device will be addressed as a separate device for each model and series to which it will be converted and ECAA qualification sought. An ECAA evaluation is required for each configuration. For example, if an operator seeks qualification for two models of an airplane type using a convertible device, two ATGs or a supplemented ATG. and two evaluations are required.

i. The airplane manufacturer's flight test data are the accepted standard for initial qualification of Levels 6 and 7 flight training devices due to the specific airplane aerodynamic programming necessary. Exceptions to this policy may be made, but must first be submitted to the ECAA for review and consideration.

j. If flight test data from a source in addition to or independent of the airplane manufacturer's data are to be submitted in support of a flight training device qualification, it must be acquired in accordance with normally accepted professional flight test methods. Proper consideration for the following must be an intrinsic part of the flight test planning.

(1) Appropriate and sufficient data acquisition equipment or system.

(2) Current calibration of data acquisition equipment and airplane. Performance instrumentation (calibration must be traceable to a recognized standard).

(3) Flight test plan, including:

(i) Maneuvers and procedures.

(ii) Initial conditions.

(iii) Flight condition.

(iv) Aircraft configuration.

(v) Weight and center of gravity.

(vi) Atmospheric ambient and environmental conditions.

(vii) Data required.

(viii) Other appropriate factors.

(4) Appropriately qualified flight test personnel.

(5) Data reduction and analysis methods and techniques.

(6) Data accuracy. The data must be presented in a format that supports the flight training device validation.

(7) Resolution must be sufficient to determine compliance with the tolerances of appendix 2.

(8) Presentation must be clear with necessary guidance provided.

(9) Overplots must not obscure the reference data.

(10) The flight test plan should be reviewed with the National Simulator Program Staff well in advance of commencing the flight test. After completion of the tests, a flight test report should be submitted in support of the validation data. The report must contain sufficient data and rationale to support qualification of the device at the level requested.

k. For a new type or model of airplane, predicted data validated by flight test data, which has not been finalized and made official by the manufacturer, can be used for an interim period as determined by the ECAA. In the event predicted data are used in programming the device, an update should be accomplished as soon as practicable when actual airplane flight test data become available. Unless specific conditions warrant otherwise, this update should occur within 6 months after release of the final flight test data package by the airplane manufacturer.

l. Levels 2, 3, and 5 flight training devices do not require a specific aerodynamic model; however, their performance must be compared to a reference set of validation data for initial qualification and for repeated recurrent evaluations. (Note: Level 4 requires no aerodynamic model.) In the absence of a specific model, these devices may use a generic model typical of the set of airplanes as described in this EAC. For example, a twin engine, turbojet transport airplane flight training device must demonstrate the performance and handling typical of that set of airplanes. Similarly, a light twin or single engine airplane flight training device must demonstrate performance typical of the respective set of airplanes. The aerodynamic model may be one representing an actual airplane within that set of airplanes or it may be created or derived using the same mathematical expressions as those used in a specific model, but with coefficient values which are not obtained from flight test results for a particular airplane. Instead, the coefficient values could be fictitious, but be typical of the set of airplanes replicated. The reference validation data could then be created by doing a computer simulation using these fictitious coefficients. A generic model may also be acquired from public domain resources or it may be a composite of various models, none of which is complete within itself.

(1) It is the responsibility of the operator to demonstrate that the reference data used represent the appropriate set of airplanes. To assure that it continues to comply with its original qualification status, each flight training device will be compared to the accepted reference data for subsequent recurrent evaluations.

(2) The ECAA is the acceptance authority for adequacy and suitability of this data and will resolve questions which may arise over its application. Once reference data for a specific set of airplanes is accepted by the ECAA, this data will be considered accepted for that set of airplanes without a requirement for further review and approval.

m. If a problem with a validation test result is detected by the ECAA evaluator, the test may be repeated. If it still does not meet the test tolerance, the operator may demonstrate alternative test results which relate to the test in question. In the event a validation test does not meet specified criteria, but is not considered critical to the level of evaluation being conducted, the operator or ECAA, may conditionally qualify the training device at that level and the operator will be given a specified period of time to correct the problem and submit the ATG changes for evaluation. Alternatively, if it is determined that the results of a validation test would have a detrimental effect on the level of qualification being sought or is a firm regulatory requirement, the device may be qualified to a lesser level or restricted from training and checking events affected by the failed test. For example, if a Level 5 qualification is requested and the device fails to meet a Level 5 requirement, the device could be ATG to the ECAA with the appropriate transmittal memorandum. For devices not: qualified at Level 4 provided all Level 4 requirements have been met.

n. Within 20 working days of receiving an acceptable ATG, the ECAA will coordinate with the operator to set a mutually acceptable date for the evaluation. Evaluation dates will not be established until the ATG has been reviewed and determined to be acceptable. To avoid unnecessary delays, operators are encouraged to work closely with the ECAA, during the ATG development process prior to making formal application. All Levels 6 and 7 devices must be evaluated by the ECAA, and operators must forward the requiring ECAA qualification (Levels 2 - 5), the operator will evaluate the ATG in accordance with the guidance of this Subpart.

o. At the discretion of the ECAA Simulator Evaluation Specialist, the operator's pilots may assist during evaluations in completing the functions and validations tests. However, only ECAA personnel should manipulate the pilot controls during the functions check portion of an ECAA evaluation.

p. ECAA evaluations Of flight training devices located outside Egypt will be performed if title device is used by an Egyptian operator in satisfying any training event or checking event requirements, including certification of Egyptian airmen. Evaluations may be conducted otherwise as deemed appropriate by the ECAA on a case-by-case basis.

q. Upon qualification of the flight training device (whether by the ECAA or the operator), approval for the use of the device in an ECAA approved training program is the responsibility of the operator.

## 8. INITIAL OR UPGRADE EVALUATIONS.

a. An operator seeking flight training device initial or upgrade evaluation must submit a request in writing to the ECAA. Evaluations will normally be accomplished by a representative of the operator’s inspector for Levels 2 through 5, and must be accomplished by the ECAA for Levels 6 and 7. If the flight training device is proposed to be Level 6 or 7, the operator will promptly forward the ATG to the

ECAA. All requests should contain a compliance statement certifying that the device meets all of the provisions of this EAC, that the cockpit configuration conforms to that of the airplane, that specific hardware and software configuration control procedures have been established, and that the pilot(s) designated by the operator confirm that it is representative of the airplane in all appropriate functions test areas. A sample letter of request is included in appendix 4.

b. The operator should submit an ATG which includes:

(1) A title page with the operator and ECAA signature blocks.

(2) A flight training device information page, for each configuration in the case of convertible devices, providing the following information, if applicable:

(i) The operator's flight training device identification number or code.

(ii) Airplane, or set of airplanes, as appropriate, being simulated.

(iii) Source of aerodynamic data and any appropriate revision reference.

(iv) Engine model (and data revision, as applicable), if appropriate.

(v) Flight control data revision, if appropriate.

(vi) Flight Management System identification (and revision level), if appropriate.

(vii) Flight training device model and manufacturer.

(viii) Date of device manufacture.

(ix) Computer identification, if appropriate.

(x) Visual system model and manufacturer, if installed.

(xi) Motion system type and manufacturer, if installed.

(3) Table of contents.

(4) Log of revision and/or list of effective pages.

(5) Listing of all other reference or source data, if applicable.

(6) Glossary of terms and symbols used.

(7) Statements of Compliance (SOC) as may be required in appendix1, "Flight Training Device Standards," comments column, for SOC requirements.

(8) A list of equipment required to accomplish the validation tests and a description of the appropriate procedures to be followed to record the test results. If testing and recording are to be accomplished automatically, a listing of the equipment and appropriate procedures should be included.

(9) The following is needed for each validation test designated in appendix 2 of this Subpart:

(i) Name of the test.

(ii) Objective of the test.

(iii) Initial conditions.

(iv) Method for evaluating validation test results.

(v) Tolerances for relevant parameters.

(vi) Source of validation reference data.

(vii) Copy of validation reference data.

(viii) Validation test results as obtained by the operator.

(ix) A means, acceptable to the ECAA, of easily comparing the training device test results to validation reference data.

c. Test results should be labeled using terminology common to airplane parameters as opposed to computer software identifications or other references. These results should be easily compared with the supporting data by employing cross plotting, overlays, transparencies, or other acceptable means. Use of Multi-channel recorder, line printer, or similar recording media is encouraged for all flight training device levels; however, regardless of the media used, it must be acceptable to the ECAA. Data reference documents included in an ATG may be reduced photographically only if such reduction will not alter the graphic scaling or cause difficulties in scale interpretation or resolution. Incremental scales on graphical presentations must provide the resolution necessary for evaluation of the parameters shown in appendix 2. The test guide will provide the documented proof of compliance with the validation tests in appendix 2. In the case of an upgrade, an operator should run the validation tests for the requested qualification level. Validation test results offered in a test guide for a previous initial or upgrade evaluation should not be used to validate flight training device performance in a test guide offered for a current upgrade. Flight training device test results should be clearly marked with appropriate reference points to ensure an accurate comparison between training device and validation reference data with respect to time when tests involve time history parameters. Operators using line printers to record time histories should clearly mark that information taken from the line printer data output for cross plotting on the airplane data. The cross plotting of the operator's flight training device data to the reference data is essential to verify performance in each test. During an evaluation, the ECAA will devote its time to detailed checking of selected tests from the ATG. The ECAA evaluation serves to validate the operator's test results.

d. The completed ATG, as well as the operator's compliance letter and request for the evaluation, will be submitted to the ECAA. For ATGs requiring ECAA review, the operator will submit the total package to the ECAA. The ATG will be reviewed and determined to be acceptable prior to scheduling an evaluation of the device. Should the operator desire ECAA assistance with ATG evaluation for devices not requiring ECAA review, a request should be prepared and forwarded with the ATG to the ECAA.

e. The operator may elect to accomplish the ATG validation tests while the flight training device is at the manufacturer's facility. Tests at the manufacturer's facility should be accomplished at the latest practical time prior to disassembly and shipment. The operator must then validate the performance of the device at the final location by repeating at least one-third of the validation tests in the ATG and submitting those tests to ECAA, if appropriate. After review of these tests, the ECAA will schedule an initial evaluation. The ATG must be clearly annotated to indicate when and where each test was accomplished.

f. In the event an operator moves a flight training device to a new location and its level of qualification is not changed, the following procedures shall apply:

(1) Advise the ECAA prior to the move.

(2) Prior to returning the flight training device to service at the new location, the operator should perform a typical recurrent validation and functions test. The results of such tests will be retained by the operator and be available for inspection by the ECAA at the next evaluation or as requested.

(3) The ECAA may schedule an evaluation prior to return to service.

g. When there is a change of operator, the new operator must accomplish all required administrative procedures including the submission of the currently approved ATG to the ECAA. The ATG must be identified with the new operator by displaying the operator's name or logo. The operator will then submit the package as described in paragraph 7d above. The flight training device may, at the discretion of the ECAA, be subject to an evaluation in accordance with the original qualification criteria.

h. The scheduling priority for initial and upgrade evaluations will be based on the sequence in which acceptable ATGs and evaluation requests are received by the ECAA.

i. The ATG will be approved after the completion of the initial or upgrade evaluation and all discrepancies in the ATG have been corrected. This document, after inclusion of the ECAA witnessed test results, becomes the MATG. The MATG will then remain in the custody of the operator for use in future recurrent evaluations.

j. A copy of an MATG for each type flight training device (Levels 6 and 7 only) by each manufacturer will be required for the ECAA's file. The ECAA may elect not to retain copies of the ATG for subsequent devices of the same type by a particular manufacturer but will determine the need for copies on a case-by-case basis. Data updates to an original ATG should be provided to the ECAA in order to keep ECAA file copies current.

## 9. RECURRENT EVALUATIONS.

a. For a flight training device to retain its qualification, it will be evaluated on a recurrent basis using the approved MATG. Evaluations will normally be accomplished by a representative of the operator for Levels 2 through 5 and must be accomplished by the ECAA for Levels 6 and 7. Each recurrent evaluation will consist of functions tests and at least a portion of the validation tests in the MATG.

b. The recurrent evaluations will be planned for every 4 months with approximately one-third of the validation tests in the MATG accomplished each time. This will allow all MATG tests to be accomplished annually. However, with appropriate arrangement and understanding between the operator and the ECAA, an extended interval recurrent evaluation schedule can be arranged. This decision may be made at the conclusion of the initial evaluation and the operator notified within 30 days.

(1) For Levels 2, 3, and 4, the extended interval may be based on annual evaluations by the ECAA with all MATG tests accomplished at each successive evaluation.

(2) For Levels 5, 6, and 7, the extended interval may be based on semiannual evaluations by the ECAA with the operator accomplishing quarterly checks.

c. Dates of recurrent evaluations normally will not be scheduled beyond 30 days of the due date. Exceptions to this policy will be considered by the ECAA on a case-by-case basis to address extenuating circumstances.

d. In the interest of conserving training device time, the following Optional Test Program (OTP), applicable to Levels 6 and 7, is an alternative to the standard recurrent evaluation procedure:

(1) Operators having the appropriate automatic recording and plotting capabilities may apply for evaluation under the OTP.

(2) Operators must notify the ECAA in writing of their intent to enter the OTP. If the ECAA determines that the evaluation can be accommodated with 4 hours or less of training device time, recurrent evaluations for that device will be planned for 4 hours. If the 4-hour period is or will be exceeded and the operator cannot extend the period, then the evaluation will be terminated and must be completed within 30 days to maintain qualification status. The ECAA will then reassess the appropriateness of the OTP.

(3) Under the OTP, at least one-third of all the validation tests will be performed and certified by operator personnel between ECAA recurrent evaluations. Complete coverage will be required through any three consecutive recurrent evaluations. These tests and the recording of the results should be accomplished within the 30 days prior to the scheduled evaluation or accomplished on an evenly distributed basis during the 4-month period preceding the scheduled evaluation. This information will be reviewed by the ECAA Simulator Evaluation Specialist at the outset of each recurrent evaluation. At least 20 percent of those tests conducted by the operator for each recurrent evaluation will then be selected and repeated by the Simulator Evaluation Specialist along with at least 10 percent of those tests not performed by the operator.

e. In instances where an operator plans to remove a flight training device from active status for prolonged periods, the following procedures shall apply to re-qualify the flight training device pursuant to this EAC:

(1) The ECAA shall be advised in writing. The notice shall contain an estimate of the period that the device will be inactive.

(2) Recurrent evaluations will not be scheduled during the inactive period. The ECAA will remove the flight training device from qualified status on a mutually established date not later than the date on which the first missed recurrent evaluation would have been scheduled.

(3) Before a device can be restored to ECAA qualified status, it will require an evaluation by the ECAA. The evaluation content and time required for accomplishment will be based on the number of recurrent evaluations missed during the inactive period. For example, if the training device were out of service for 1 year, it would be necessary to complete the entire test guide since under the recurrent evaluation program, the MATG is to be completed annually.

(4) The operator will notify the ECAA of any changes to the original scheduled time out of service.

(5) The flight training device will normally be re-qualified using the ECAA approved MATG and criteria that was in effect prior to its removal from qualification; however, inactive periods exceeding 1 year will require a review of the qualification basis.

(6) If these procedures are not possible, the establishment of a new qualification basis will be necessary.

## 10. SPECIAL EVALUATIONS.

a. Between recurring evaluations, if deficiencies are discovered or it becomes apparent that the flight training device is not being maintained to initial qualification standards, a special evaluation may be conducted by the operator, or ECAA if appropriate, to verify its status.

b. The flight training device will lose its qualification when the ECAA can no longer ascertain maintenance of the original validation criteria based on a recurrent or special evaluation. Additionally, the operator shall advise the ECAA, if appropriate, if a deficiency is jeopardizing training requirements, and arrangements shall be made to resolve the deficiency in the most effective manner, including the withdrawal of approval by the ECAA

.

## 11. MODIFICATION OF FLIGHT TRAINING DEVICES.

a. Operators must notify the ECAA if appropriate, at least 21 days prior to making software program or hardware changes which impact flight or ground dynamics. A complete list of these planned changes and identification of proposed updates to the MATG must be provided in writing. Operators should maintain a configuration control system to ensure the continued integrity of the device and to account for changes incorporated. The configuration control system may be examined by the ECAA on request.

b. Modifications which impact flight or ground dynamics, systems functions, and significant ATG revisions may require an ECAA evaluation of the flight training device.

## 12. QUALIFICATION BASIS.

The ECAA requires that training devices must maintain their performance, functions, and other characteristics as originally evaluated and qualified. Except as provided for in paragraph 2, all recurrent evaluations of those flight training devices using the acceptable methods of compliance described in this Subpart for initial or upgrade evaluation (including any visual or motion systems installations) will be conducted in accordance with the provisions herein.

## 13. DOWNGRADE OF AN AIRPLANE SIMULATOR TO AN AIRPLANE FLIGHT TRAINING DEVICE.

An operator may elect to have a currently qualified airplane simulator reclassified as a flight training device. This may be accomplished through one of two methods.

a. Normal. The operator would follow the steps outlined in this Subpart for the evaluation and qualification of a flight training device irrespective of the device's current status as an airplane simulator.

b. Administrative. The operator would request that the currently qualified airplane simulator be downgraded to a flight training device. This process would not require an on-site evaluation of the device and would be in accordance with the following:

(1) Conditions.

(i) A Level C or D airplane simulator may be administratively reclassified as a Level 6 or 7 airplane flight training device at the operator's option. A Level A or B airplane simulator may be administratively reclassified as a Level 6 airplane flight training device.

(ii) The existing qualification basis for the simulator will remain the basis for qualification of the flight training device, including all aspects of the MATG, except for those tests applicable to the notion or visual systems. The motion and visual systems should be deactivated, although physical removal from the device is not required. Should the operator wish to have the availability of either the motion or visual systems, those appropriate tests would remain a part of the MATG for the flight training device.

(iii) Frequency and content of recurrent evaluations would remain unchanged except for MATG modifications that may occur under (1)(ii), above.

(2) Procedures.

(i) The operator must notify the ECAA, in writing, of the desire to administratively downgrade their airplane simulator.

(ii) This notification must include appropriate page changes to the current MATG indicating, at least, the change in status and the elimination of appropriate tests as described under (1)(ii), above.

(iii) After review of this notification package and concluding that the modified MATG would support the flight training device qualification level sought, the ECAA may issue a qualification letter.

c. Situations that may not be addressed by either of the above two methods will be considered on a case-by-case basis.

## 14. PREVIOUSLY APPROVED FLIGHT TRAINING DEVICES.

a. Those flight training devices which, for any reason, are not capable of meeting, or it is not desired that they meet, the qualification standards for a specified level as described in this Subpart, but which have been previously approved for use, and/or have been issued an authorization letter from the ECAA, will be eligible for qualification under a temporary status. This temporary status will remain valid for a period not to exceed a date 2 years after the effective date of this EAC, and will allow continued use of the device as authorized for this time period.

b. Any such device which is physically modified with the intent of meeting a qualification standard set out in this EAC, but which, for any reason, has not demonstrated that it meets the standards for a specific level, will have this temporary status conferred, or continued, only if the following conditions are met:

(1) The device was manufactured and has been approved prior to the effective date of this EAC;

(2) ECAA is notified that such a modification is planned; and

(3) The performance of the modified device is determined ECAA to meet, or exceed, that of the original equipment. This determination would be solely subjective in nature and would be based on those maneuvers/procedures for which the device had been previously approved. In the interest of information gathering, the ECAA would request that the person(s) involved in the design and/or installation of such modifications provide documentation, test results, conclusions, etc., to the ECAA.

# APPENDIX 1.
# FLIGHT TRAINING DEVICE STANDARDS

## 1. DISCUSSION.

This appendix describes the minimum flight training device requirements for qualification at Levels 1 through 7. The appropriate Part, as indicated in paragraph 3 of this EAC, must be consulted when considering particular training device requirements. The validation and functions tests listed in appendices 2 and 3 must also be consulted when determining the requirements of a specific level training device. In the following tabular listing of training device requirements, needed statements of compliance and statements of explanation are indicated in the comment column.

*KEY:* 1 - Training device requirements. 2 - Level 1. 3 - Level 2. 4 - Level 3. 5 - Level 4. 6 - Level 5. 7 - Level 6. 8 - Level 7. 9 - Comments

## 2. GENERAL

1 - a. A cockpit which will have actuation.. 4 - X. 7 - X. 8 - X. 9 - Level 3 must be representative of a single set of airplanes, and must have navigation controls, displays, and instrumentation as set out in Part91 for operation in accordance with instrument flight rules (IFR).

1 - b. Instruments, equipment, panels, systems, and controls sufficient for the training/checking events to be accomplished must be located in a spatially correct open flight deck area. Actuation of these controls and switches must replicate those in the airplane. 3 - X. 5 - X. 6 - X. 9 - Level 2 must be representative of a single set of airplanes. Levels 2 and 5 require simulated aerodynamic capability and control forces and travel sufficient to manually fly an instrument approach.

1 - c. Daily preflight documentation. . 3 - X. 4 - X. 5 - X. 6 - X. 7 - X. 8 - X

1 - d. Lighting environment for panels and instruments must be sufficient for the operation being conducted. . 3 - X. 4 - X. 5 - X. 6 - X. 7 - X. 8 - X. 9 - Lighting must be as per airplane lighting for Level 7.

1 - e. Circuit breakers should function accurately when they are involved in operating procedures or malfunctions requiring or involving flight crew response.. 3 - X. 4 - X. 5 - X. 6 - X. 7 - X. 8 - X. 9 - Must be properly located in Levels 6 and 7.

1 - f. Effect of aerodynamic changes for various combinations of drag and thrust normally encountered in flight, including the effect of change in airplane attitude, thrust, drag, altitude, temperature, and configuration. . 3 - X. 4 - X. 6 - X. 7 - X. 8 - X. 9 - Levels 3, 6, and 7 require additionally, the effects of gross weight and center of gravity.

1 - g. Digital or analog computing of sufficient capacity to conduct complete operation of the device including its evaluation and testing.. 3 - X. 4 - X. 5 - X. 6 - X. 8 - X

1 - h. All relevant instrument indications involved in the simulation of the applicable airplane entirely automatic in response to control input.. 3 - X. 4 - X. 6 - X. 7 - X. 8 - X

1 - i. Navigation equipment corresponding to that installed in the replicated airplane with operation within the tolerances prescribed for the actual airborne equipment. 3 - . . 4 - X. 6 - X. 7 - X. 8 - X. 9 - Levels 3, 6, and 7 must also include communication equipment (interphone and air/ground) corresponding to that installed in the replicated aircraft, and, if appropriate, to the operation being conducted, an oxygen mask microphone/communication system. Levels 2 and 5 need have operational only that navigation equipment sufficient to fly a non-precision instrument approach.

1 - j. Crewmember seats must afford the capability for the occupant to be able to achieve the design eye reference position for specific airplanes, or to approximate such a position for a generic set of airplanes.. 4 - X. 6 - X. 7 - X. 8 - X. 9 - Level 7 crewmember seats must accurately simulate those installed in the airplane.

1 - k. In addition to the flight crewmember stations, suitable seating arrangements for an instructor/check airman and ECAA inspector. These seats must provide adequate view of crewmember's panel(s). 3 - X. 4 - X. 5 - X. 6 - X. 7 - X. 8 - X. 9 - These seats need not be a replica of an aircraft seat and can be as simple as an office chair placed in an appropriate position.

1 - l. Installed system(s) must simulate the applicable airplane system operation, both on the ground and in flight. At least one airplane system must be represented. System(s) must be operative to the extent that applicable normal, abnormal, and

emergency operating procedures included in the operator's training programs can be accomplished. 3 - X. 4 - X. 5 - X. 6 - X. 7 - X. 8 - X. 9 - Levels 6 and 7 must simulate all applicable airplane flight, navigation, and systems operation. Level 3 must have flight and navigational controls, displays, and instrumentation for powered aircraft as set out in Part91 for IFR operation. Levels 2 and 5 must have functional flight and navigational controls, displays, and instrumentation.

1 - m. Instructor controls that permit activation of normal, abnormal, and emergency conditions, as may be appropriate. Once activated, proper system operation must result from system management by the crew and not require input from the instructor controls. 3 - X. 4 - X. 5 - X. 6 - X. 7 - X. 8 - X

1 - n. Control forces and control travel which correspond to that of the replicated airplane, or set of airplanes. Control forces should react in the same manner as in the airplane, or set of airplanes, under the same flight conditions. 3 - X. 4 - X. 6 - X. 7 - X. 8 - X. 9 - Levels 2 and 5 need control forces and control travel only of sufficient precision to manually fly an instrument approach.

1 - o. Significant cockpit sounds which result from pilot actions corresponding to those of the airplane. 4. - X. 7 - X. 8 - X

1 - p. Sound of precipitation, windshield wipers, and other significant airplane noises perceivable to the pilot during normal, abnormal, or emergency operations, as may be appropriate. 8 - X. 9 - Statement of Compliance.

1 - q. Aerodynamic modeling which, for airplanes issued an original type certificate after June 1980, includes low altitude level flight ground effect, Mach effect at high altitude, effects of airframe icing, normal dynamic thrust effect on control surfaces, aeroelastic representations, and representations of non-linearities due to sideslip based on airplane flight test data provided by the manufacturer. 8 - X. 9 - Statement of Compliance. Tests required. See appendix 2 for further information. The statement must address ground effect, Mach effect, aeroelastic representations, and non-linearities due to sideslip. Separate tests for thrust effects and demonstration of icing effects are required.

1 - r. Control feel dynamics which replicate the airplane simulated. Free response of the controls shall match that of the airplane within the tolerance given in appendix 2. Initial and upgrade evaluation will include control free response (column, wheel, and pedal) measurements recorded at the controls. The measured responses must correspond to those of the airplane in takeoff, cruise, and landing configurations.

(1) For airplanes with irreversible control systems, measurements may be obtained on the ground if proper pilot static inputs are provided to represent conditions typical of those encountered in flight. Engineering validation or airplane manufacturer rationale will be submitted as justification to ground test or omit a configuration.

(2) For flight training devices requiring static and dynamic tests at the controls, special test fixtures will not be required during initial evaluations if the operator's ATG shows both test fixture results and alternate test method results, such as computer data plots, which were obtained concurrently. Repeat of the alternate method during the initial evaluation may then satisfy this test requirement.

8 - X. 9 - Statement of Compliance. Tests required. See appendix 2, paragraph 3.

1 - s. Aerodynamic and ground reaction modeling for the effects of reverse thrust on directional control. 8 - X. 9 - Statement of Compliance. Tests required.

1 - t. Timely permanent update of flight training device hardware and programming consistent with airplane modifications. 3 - X. 4 - X. 5 - X. 6 - X. 7 - X. 8 - X

1 - u. Visual system; if installed (not required). 3 - X. 4 - X. 5 - X. 6 - X. 7 - X. 8 - X. 9 - Visual system standards set out in Subpart 120-40, as amended, for at least Level A simulators will be acceptable.

1 - v. Motion system; if installed (not required). 3 - X. 4 - X. 5 - X. 6 - X. 7 - X. 8 - X. 9 - Motion system standards set out in Subpart EAC 121-1, as amended, for at least Level A simulators will be acceptable.

# APPENDIX 2.
# FLIGHT TRAINING DEVICE VALIDATION TESTS

## 1. DISCUSSION.

Performance must be objectively evaluated by comparing the results of tests conducted in the training device to aircraft flight test data unless specifically noted otherwise. Test requirements listed in the table may not be applicable in cases in which the flight training device does not include the system or function to be checked. In other cases a system or function may be included and evaluated in the flight training device which would normally not be required for the level of qualification being sought.

The ATG provided by the operator must describe clearly and distinctly how the flight training device will be set up and operated for each test. Use of a driver program designed to automatically accomplish the tests is encouraged for all flight training devices. A manual test procedure with explicit and detailed steps for completion of each test must also be provided. The tests and tolerances contained in this appendix must be included in the operator's ATG.

The Table of Validation Tests of this appendix generally indicates the test results required. Unless noted otherwise, tests should represent airplane performance and handling qualities at normal operating weights and centers of gravity (CG). If a test is supported by aircraft data at one extreme weight or CG, another test supported by aircraft data at mid-conditions or as close as possible to the other extreme should be included. Certain tests which are relevant only at one extreme CG or weight condition need not be repeated at the other extreme. It should be recognized that the tests listed in the table merely sample, on a very limited basis, the flight training device performance and handling qualities. The results of these tests for Levels 3, 6, and 7 are expected to be indicative of the device's performance and handling qualities throughout the airplane weight and CG envelope, the operational envelope, and for varying atmospheric ambient and environmental conditions to the extremes authorized for the respective airplane or set of airplanes. It is not sufficient, nor is it acceptable, to program these flight training devices so that the modeling is correct only at the validation test points.

Test of handling qualities must include validation of augmentation devices. Flight training devices for highly augmented airplanes will be validated both in the unaugmented configuration (or failure state with the maximum permitted degradation in handling qualities) and the augmented configuration. Where various levels of handling qualities result from failure states, validation of the effect of the failure is necessary. Requirements for testing will be mutually agreed to between the operator and the ECAA on a case-by-case basis.

## 2. TEST REQUIREMENTS.

The ground and flight tests required for qualification are listed in the Table of Validation Tests. Results of these tests should be available in a form which can be compared to validation reference data. For those devices listed in the following table requiring generic aerodynamic modeling, the ECAA approved data supplied by the manufacturer or the operator sponsoring the device will be used as the comparison basis for objective testing.

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

a. Parameters, Tolerances, and Flight Conditions. The Table of Validation Tests in this appendix describes the parameters, tolerances, and flight conditions for training device validation. If a flight condition or operating condition is shown which does not apply to the qualification level sought, it should be disregarded. Results must be labeled using the tolerances and units given.

b. Flight Conditions Verification. When comparing the parameters listed to those of the airplane, sufficient data must also be provided to verify the correct flight condition. For example, to show that control force is within ±5 lb (2.224 daN) in a static stability test, data to show the correct airspeed power, thrust or torque, airplane 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 airplane, but airspeed, altitude, control input, airplane configuration, and other appropriate data must also be given. All airspeed values should be clearly annotated as to indicated, calibrated, etc., and like values used for comparison.

## TABLE OF VALIDATION TESTS

KEY: 1 - Test. 2 - Tolerance. 3 - Flight Condition. 4 - Qualification Requirement - Level(s). 5 - Comments

**1. PERFORMANCE**

a. TAKEOFF:

1 - (1) Ground Acceleration Time. 2 - ±5% Time or. ±1 Second. 3 - Ground/Takeoff. 4 - 3, 6, 7. 5 - Level 7 devices will required distance measurements also. Tolerances will be ±5% time and distance or ±5% time and ±200 feet (60 meters) of distance. Acceleration time (and distance for Level 7) should be recorded for a minimum of 80% of total segment (brake release to Vr).

1 - (2) Minimum Unstick Speed or equivalent as provided by the aircraft manufacturer. 2 - ±3 Kts Airspeed. ±1.5 Pitch. 3 - Ground/Takeoff. 4 - 7. 5 - Vmu is defined as that speed at which the last main landing gear leaves the ground.

1 - (3) Normal Takeoff. 2 - ±3 Kts Airspeed. ±1.5 Pitch, ±1.5° Angle-of-Attack. ±20 Feet (6 Meters) Altitude. 3 - Ground/Takeoff and First Segment of Climb. 4 - 7

1 - (4) Critical Engine Failure on Takeoff. 2 - ±3 Kts Airspeed. ±1.5 Pitch, ±1.5° Angle-of-Attack. ±20 Feet (6 Meters) Altitude. ±2° Bank and Sideslip Angle. 3 - Ground/Takeoff and First Segment of Climb. 4 - 7

1 - (5) Crosswind Takeoff. 2 - ±3 Kts Airspeed. ±1.5 Pitch, ±1.5° Angle-of-Attack. ±20 Feet (6 Meters) Altitude. ±2° Bank and Sideslip Angle. 3 - Ground/Takeoff and First Segment of Climb.4 - 7

b. CLIMB

1 - (1) Normal Climb All Engines Operating. 2 - ±3 Kts Airspeed. ±5% or ±100 FPM (0.5 Meters/Sec) Climb Rate. 3 - Climb With All Engines Operating. 4 - 2, 3, 5, 6, 7. 5 - May be a snapshot test.

1 - (2) One Engine Inoperative Second Segment Climb. 2 - ±3 Kts Airspeed. ±5% or ±100 FPM (0.5 Meters/Sec) Climb Rate but not less than the ECAA Approved Flight Manual Rate of Climb. 3 - Second Segment Climb With One Engine Inoperative. 4 - 7

1 - (3) One Engine Inoperative Approach Climb for Airplanes With Icing Accountability per Approved Airplane Flight Manual (AFM). 2 - ±3 Kts Airspeed. ±5% or ±100 FPM (0.5 Meters/Sec) Climb Rate but not less than the ECAA Approved Flight Manual Rate of Climb. 3 - Approach Climb With One Engine. 4 - 7

c. IN FLIGHT

1 - (1) Stall Warning, Stall Speeds. 2 - ±3 Kts Airspeed. ±2° Bank. 3 - Second Segment Climb and Approach or Landing. 4 - 7

1 - (2) Stall Warning (actuation of stall warning device). 2 - ±3 Kts Airspeed. ±2° Bank. 3 - Second Segment Climb and Approach or Landing. 4 - 2, 3, 5, 6

d. STOPPING

1 - (1) Stopping Time, Wheel Brakes Dry Runway. 2 - ±5% time or ±1 Second. 3 - Landing. 4 - 3, 6, 7. 5 - Level 7 devices will require distance measurements also. Tolerances will be ±5% time and the smaller of ±10% of distance or 200 feet (60 meters).. Time (and Distance for Level 7) should be recorded for at least 80% of total segment. (Initiation of Rejected Take Off [RTO] to full stop).

1 - (2) Stopping Time, Reverse Thrust Dry Runway. 2 - ±5% Time or ±1 Second. 3 - Landing. 4 - 3, 6, 7. 5 - Level 7 devices will require distance measurements also. Tolerances will be ±5% time and the smaller of ±10% of distance or 200 feet (60 meters).. Time (and Distance for Level 7) should be recorded for at least 80% of total segment. (Initiation of RTO to full stop.)

1 - (3) Stopping Time and Distance, Wheel Brakes Only Wet Runway. 2 - Representative Stopping Time and Distance. 3 - Landing. 4 - 7. 5 - Time and Distance should be recorded for at least 80% of total segment. (Initiation of RTO to full stop.) ECAA approved AFM data is acceptable.

1 - (4) Stopping Time and Distance, Wheel Brakes Only Icy Runway. 2 - Representative Stopping. Time and Distance. 3 - Landing. 4 - 7. 5 - Time and Distance should be recorded for at least 80% of total segment. (Initiation of RTO to full stop.) ECAA approved AFM data is acceptable.

e. ENGINES

1 - (1) Acceleration. 2 - ±10% Time. 3 - Approach or Landing. 4 - 2, 3, 5, 6, 7. 5 - Test from flight idle to go-around power. Tolerances of ±1 second authorized for Levels 2, 3, and 5.

1 - (2) Deceleration. 2 - ±10% Time. 3 - Ground/Takeoff. 4 - 2, 3, 5, 6, 7. 5 - Test from maximum takeoff power to 10% of maximum takeoff power (90% decay in power available above idle). Tolerance of ±1 second authorized for Levels 2, 3, and 5.

## 2. HANDLING QUALITIES

a. STATIC CONTROL CHECKS /**/

/**/ - Column, wheel, and pedal position vs force shall be measured at the control. An alternative method acceptable to the NSPM in lieu of the test fixture at the controls would be to instrument the training device in an equivalent manner to the flight test airplane. The force and position data from this instrumentation can be directly recorded and matched to the airplane data. Such a permanent installation could be used repeatedly without any time for installation of external devices.

1 - (1) Column Position vs. Force and Surface Position Calibration. 2 - ±2 lb (0.89 daN) Breakout. ±5 lb (2.224 daN) or ±10% Force. ±2° Elevator. 3 - Ground. 4 - 6, 7. 5 - Uninterrupted control sweep.

1 - (1) Column Position vs Force. 2 - ±2 lb (0.89 daN) Breakout. ±5 lb (2.224 daN) or 10% Force. 4 - 2, 3, 5

1 - (2) Wheel Position vs Force and Surface Position Calibration. 2 - ±2 lb (0.89 daN) Breakout. ±3 lb (1.334 daN) or ±10% Force. ±1° Aileron. ±2° Spoiler. 3 - Ground. 4 - 6, 7. 5 - Uninterrupted control sweep.

1 - (2) Wheel Position vs Force. 2 - ±2 lb (0.89 daN) Breakout. ±3 lb (1.334 daN) or ±10% Force. 4 - 2, 3, 5

1 - (3) Pedal Position vs Force and Surface Position Calibration. 2 - ±5 lb (2.24 daN) Breakout. ±5 lb (2.224 daN) or ±10% Force. ±2° Rudder. 3 - Ground. 4 - 6, 7. 5 - Uninterrupted control sweep.

1 - (3) Pedal Position vs Force. 2 - ±5 lb (2.24 daN) Breakout. ±5 lb (2.224 daN) or ±10% Force. 4 - 2, 3, 5

1 - (4) Nose Wheel Steering Force. 2 - ±2 lb (0.89 daN) Breakout. ±3 lb (1.3334 daN) or ±10% Force. 3 - Ground. 4 - 3, 6, 7. 5 - If appropriate to the airplane or set of airplanes being simulated.

1 - (5) Rudder Pedal Steering Calibration. 2 - ±2° Nose Wheel Angle. 3 - Ground. 4 - 3, 6, 7. 5 - If appropriate to the airplane or set of airplanes being simulated.

1 - (6) Pitch Trim Calibration Indicator vs Computed. 2 - ±0.5° of Computed Trim Angle. 3 - Ground. 4 - 6, 7

1 - (7) Alignment of Power Lever (or Cross Shaft Angle) vs Selected Engine Parameter (that is, EPF, N(1), Torque, Manifold Pressure, etc.). 2 - ±5° of Power Lever Angle or Cross Shaft Angle o. Equivalent. 3 - Ground. 4 - 6, 7

1 - (8) Brake Pedal Position vs Force. 2 - ±2° Pedal Position. ±5 lb (2.224 daN) or 10%. 3 - Ground. . - 3, 6, 7. 5 - Computer output results may be used to show compliance. Levels 3 and 6 only need data points at zero and maximum braking application.

b. DYNAMIC CONTROL CHECKS /**/

/**/ - Column, wheel, and pedal position vs force or time shall be measured at the control. An alternative method acceptable to the NSPM in lieu of the test fixture at the controls would be to instrument the training device in an equivalent manner to the flight test airplane. The force and position data from this instrumentation can be directly recorded and matched to the airplane data. Such a permanent installation could be used repeatedly without any time for installation of external devices.

1 - (1) Pitch Control. 2 - ±10% Time for Each Zero Crossing. ±10% Amplitude of 2nd and Subsequent Overshoots Greater Than 5% of Initial Displacement.. ±1 Overshoot.. Refer to Paragraph 3 this Appendix.. 3 - Takeoff, Cruise. 4 - 7. 5 - Data should be normal control displacement in both directions. Approximately 25% to 50% of full throw.. Refer to paragraph 3 of this Appendix.

1 - (2) Roll Control. 2 - ±10% Time for Each Zero Crossing. ±10% Amplitude of 2nd and Subsequent Overshoots Greater Than 5% of Initial Displacement.. ±1 Overshoot.. Refer to Paragraph 3 this Appendix.. 3 - Takeoff, Cruise, Landing. 4 - 7

1 - (3) Yaw control. 2 - ±10% Time for Each Zero Crossing. ±10% Amplitude of 2nd and Subsequent Overshoots Greater Than 5% of Initial Displacement.. ±1 Overshoot.. Refer to Paragraph 3 this Appendix.. 3 - Takeoff, Cruise, Landing. 4 - 7

c. LONGITUDINAL

1 - (1) Power Change Dynamics. 2 - ±3 Kts Airspeed. ±100 Feet (30 Meters) Altitude. ±20% or ±1.5° Pitch. 3 - Cruise or Approach. 4 - 7

1 - (1) Power Change Force. 2 - ±5 lb or ±20%. 3 - Cruise or Approach. 4 - 2, 3, 5, 6. 5 - Snapshots will be acceptable. Power change dynamics will be accepted.

1 - (2) Flap Change Dynamics. 2 - ±3 Kts Airspeed. ±100 Feet (30 Meters) Altitude. ±20% or ±1.5° Pitch. 3 - Takeoff to Second Segment Climb, Approach to Landing. 4 - 7

1 - (2) Flap Change Force. 2 - ±5 lb or ±20%. 3 - Takeoff to Second Segment Climb, Approach to Landing. 4 - 2, 3, 5, 6. 5 - Snapshots will be acceptable. Flap change dynamics will be accepted.

1 - (3) Spoiler/Speed brake Change Dynamics. 2 - ±3 Kts Airspeed. ±100 Feet (30 Meters) Altitude. ±20% or ±1.5° Pitch. 3 - Cruise and Approach. 4 - 7

1 - (4) Gear Change Dynamics. 2 - ±3 Kts Airspeed. ±100 Feet (30 Meters) Altitude. ±20% or ±1.5° Pitch. 3 - Takeoff to Second Segment Climb, Approach to Landing. 4 - 7

1 - (4) Gear Change Force. 2 - ±5 lb or ±20%. 3 - Takeoff to Second Segment Climb, Approach to Landing. 4 - 2, 3, 5, 6. 5 - Snapshots will be acceptable. Gear change dynamics will be accepted.

1 - (5) Gear and Flap Operating Times. 2 - ±3 Seconds or 10% of Time. 3 - Takeoff, Approach. 4 - 2, 3, 5, 6, 7

1 - (6) Longitudinal Trim. 2 - ±1° Pitch Control (Stab and Elevation). ±1° Pitch Angle. ±2% Net Thrust or equivalent in Cruise. ±5% Net Thrust or equivalent in Approach and Landing. 3 - Cruise, Approach, Landing. 4 - 2, 3, 5, 6, 7. 5 - May be a snapshot.. Levels 2, 3, and 5 may use equivalent stick and trim controllers in lieu of stabilizer and elevator.

1 - (7) Longitudinal Maneuvering Stability (Stick Force/g). 2 - ±5 lb (+ 2.224 daN) or ±10% Column Force or Equivalent Surface. 3 - Cruise, Approach, Landing. 4 - 6, 7. 5 - May be a series of snapshot tests. Force or surface deflection must be in the correct direction.

1 - (8) Longitudinal Static Stability. 2 - ±5 lb (+ 2.224 daN) or ±10% Column Force or Equivalent Surface. 3 - Approach. 4 - 2, 3, 5, 6, 7. 5 - May be snapshot tests. Levels 2, 3, and 5 must exhibit positive static stability, but need not comply with the numerical tolerance.

1 - (9) Phugoid Dynamics. 2 - ±10% of Period. ±10% of Time to 1/2 or Double Amplitude or ±0.02 of Damping Ratio. 3 - Cruise. 4 - 2, 3, 5. 5 - Test should include 6 cycles or that sufficient to determine time to 1/2 amplitude, whichever is less.

1 - (10) Short Period Dynamics. 2 - ±1.5° Pitch or 2°/sec Pitch Rate. ±0.10 g Normal Acceleration. 3 - Cruise. 4 - 6, 7

d. LATERAL DIRECTIONAL

1 - (1) Minimum Control Speed, Air (Vmca), per device's Applicable Airworthiness Standard, or Low. Speed Engine Inoperative Handling Characteristics in Air. 2 - ±3 Kts Airspeed. 3 - Takeoff or Landing (whichever is most critical in airplane). 4 - 7

1 - (2) Roll Response (rate). 2 - ±10% or ±2°/sec Roll Rate. 3 - Cruise and Landing or Approach. 4 - 2, 3, 5, 6, 7

1 - (3) Roll Overshoot. 2 - ±2° or ±10% of Bank. 1 - or Response to Roll Controller Step Input. 2 - ±10% or ±2°/sec Roll Rate. 3 - Approach or Landing. 4 - 3, 6, 7

1 - (4) Spiral Stability. 2 - Correct Trend. 3 - Cruise. 4 - 2, 5. 2 - Correct Trend ±3° of Bank Angle or ±10% in 30 seconds. 3 - Cruise. 4 - 3, 6. 5 - Data averaged from multiple tests in the same direction may be used.. 2 - Correct Trend ±2° of Bank Angle or ±10% in 20 seconds. 3 - Cruise. 4 - 7. 5 . Level 7 requires test in both directions.

1 - (5) Engine Inoperative Trim. 2 - ±1° Rudder Angle or ±1° Tab Angle or Equivalent Pedal. ±2° Sideslip Angle. 3 - Second Segment Approach or Landing. 4 - 7. 5 - May be snapshot test.

1 - (6) Rudder Response. 2 - ±2°/sec or ±10% Yaw Rate or Heading Change. 3 - Approach or Landing. 4 - 6, 7. 5 - Test may be deleted if rudder input and response is shown in dutch roll test.. 2 - Roll Rate ±2° sec. Bank Angle ±3°. 3 - Approach or Landing. 4 - 2, 3, 5. 5 - Test may be roll response to a given rudder deflection.

1 - (7) Dutch Roll, Yaw Damper OFF. 2 - ±10% of Period. ±10% of Time to 1/2 or Double Amplitude or ±0.02 of Damping Ratio. 3 - Cruise and Approach or Landing. 4 - 6, 7. 5 - For Level 7, additional requirement of ±20% or 1 second of time difference between peaks of bank and sideslip.. 2 - ±10% of Period With Correct Trend and Number of Overshoots. 3 - Cruise and Approach or Landing. 4 - 3

1 - (8) Steady State Sideslip or Heading Angle. 2 - For given rudder position ±2° Bank, ±1° Sideslip, ±10% or ±2° Aileron, ±10% or ±5° Spoiler or Equivalent Wheel Position or Force. 3 - Approach or Landing. 4 - 2, 3, 5, 6, 7. 5 - May be a series of snapshot tests.

## 3. TESTING

1 - a. AUTOMATIC TESTING.

A means for quickly and effectively testing training device programming and hardware. This could include an automated system which could be used for conducting at least a portion of the tests in the ATG. 4 - 7

b. COCKPIT INSTRUMENT RESPONSE

1 - (1) Instrument Systems response to an abrupt pilot controller input, compared to airplane response for a similar input. One test is required in each axis (pitch, roll and yaw) for each of the 3 conditions. (Total 9 tests.)
2 - 150 milliseconds or less after airplane response.
3 - Takeoff, Cruise Approach or Landing
4 - 7
2 - 300 milliseconds or less after airplane response
3 - Takeoff, Cruise
4 - 2, 3, 5, 6
5 - A Statement of Compliance referencing computer operation update rates, etc., which describe how the 150/300 millisecond timing is achieved will be acceptable.
1 - Or, Transport Delay. One test is required in each axis. (Total 3 tests.)
2 - 150 milliseconds or less after airplane response.
3 - Pitch, Roll, Yaw
4 - 7
2 - 300 milliseconds or less after airplane response
3 - Pitch, Roll, yaw
4 - 2, 3, 5, 6

**3. CONTROL DYNAMICS**. The characteristics of an aircraft flight control system have a major effect on the handling qualities. A significant consideration in pilot acceptability of an aircraft is the "feel" provided through the cockpit controls. Considerable effort is expended on aircraft feel system design in order to deliver a system with which pilots will be comfortable and consider the airplane desirable to fly. In order for a flight training device to be representative, it too must present tile pilot with the proper "feel;" essentially that of the respective airplane.

Recordings such as free response to an impulse or step function are classically used to estimate the dynamic properties of electromechanical systems. In any case, it is only possible to estimate the dynamic properties as a result of only being able to estimate true inputs and responses. Therefore, it is imperative that the best possible data be collected since close matching of the control loading system to the airplane systems is essential.

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

For airplanes with irreversible control systems, measurement 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 airplanes, takeoff, cruise, and landing configurations have like effects. Thus, one may suffice for another. If either or both considerations apply, engineering validation or airplane manufacturer rationale must be submitted as justification for ground tests or for eliminating a configuration. For devices requiring static and dynamic tests at the controls, special test fixtures will not be required during initial and upgrade evaluations if the operator's ATG 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.

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

Tests to verify that control feel dynamics represent the airplane must show that the dynamic damping cycles (free response of the controls) match that of the airplane within 10 percent of period and 10 percent of damping. The method of evaluating the response is described below for the under-damped and critically damped cases. (1) Under-damped 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.

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 percent of the total initial displacement should be considered significant. The results should show the same number of significant overshoots to within one when compared against the aircraft data. This procedure for evaluating the response is illustrated in Figure 1. (2) Critically Damped or Over-damped Response. Due to the nature of critically damped responses (no overshoots), the time to reach 90 percent of the steady state (neutral point) value should be the same as the airplane within ±10 percent. The flight training device response should be critically damped also. Figure 2 illustrates the procedure.

**Tolerances:** The following table summarizes the tolerances, T. See Figures 1 and 2 for an illustration of the referenced measurements.

---

| | |
|---|---|
| T(P(0)) | ±10% of P(0) |
| T(P(1)) | ±10% of P(1) |
| T(P(n)) | ±10% of P(n) |
| T(A(n)) | ±10% of A(1), 20% of Subsequent Peaks |
| T(A(d)) | ±5% of A(d) |
| Overshoots | ±1 |

b. Alternate Method for Control Dynamics. One airplane manufacturer asserts that adjusting a control loading system for column releases may introduce an unnecessary error for normal pilot commands away from neutral. Instead of free response measurements, the system would be validated by measurements of column force as a function of bands on column rate.

For each axis of pitch, roll, and yaw, the control shall be forced to its extreme position at two distinct rates. One that achieves maximum deflection in approximately 2 seconds and one that achieves maximum deflection in approximately 1 second. Tolerances on the total force shall be the same as for the static check with the additional requirement that the dynamic increment be in the correct sense relative to the static force level. Where flight configurations influence the feel forces of the controls, these tests shall be conducted at a typical taxi, takeoff, cruise, and landing condition.

The ECAA is open to alternative means such as the one described above. Such alternatives must, however, be justified and appropriate to the application. For example, the method described here would not likely apply to other manufacturers' systems and certainly not to airplanes with reversible control systems. Hence, each case must be considered on its own merit on an ad hoc basis. Should the ECAA finds that alternative methods do not result in satisfactory performance, then more conventionally accepted methods must be used.

# APPENDIX 3.
# FUNCTIONS AND SUBJECTIVE TESTS

## 1. DISCUSSION.

Accurate replication of the airplane's systems functions will be checked at each flight crewmember position by an ECAA specialist. This includes procedures using the operator's approved manuals and checklists. Handling qualities, performance, and systems operation will be subjectively assessed by an appropriately qualified ECAA inspector.

The operator may request that the inspector assess the flight training device for a special aspect of an operator's training program during the functions and subjective portion of a recurrent evaluation. For example, such an assessment may include a portion of a Line Oriented Flight Training scenario or special emphasis items in the operator's training program, if appropriate. Unless directly related to requirement for the current qualification level, the results of such an evaluation would not affect the training device's current status.

Operational principal navigation systems including inertial navigation systems, OMEGA, or other long range systems, and the associated electronic display systems will be evaluated if installed. The inspector will include in his report the effect of the system operation and system limitations.

## 2. TEST REQUIREMENTS.

The ground and flight tests and other checks required for qualification are listed in the Table of Functions and Subjective Tests. The table includes maneuvers and procedures that are accomplished during the evaluation process to assure that the flight training device functions and performs appropriately. It must be understood that there is no direct correlation between the maneuvers and procedures in this appendix and any maneuver or procedure that may be authorized for a training event or checking event under Parts 61, 63, 121,141 or 142. Maneuvers and procedures are also included to address some features of advanced technology airplanes and innovative training programs. For example, "high angle-of-attack maneuvering" is included to provide an alternative to "approach to stalls." Such an alternative is necessary for aircraft employing flight envelope limiting systems. The portion of the table addressing pilot functions and maneuvers is divided by flight phases.

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

The functions and subjective test requirements listed in the Table are not applicable in cases in which the flight training device does not include the system or function to be checked even though it may be indicated by the "X" in the Table. This is particularly true for Levels 2, 4, and 5 which require as little as one functioning system. When using the Tables, one must apply logic to assure the required flexibility for these devices and not require unintended systems.

There are maneuvers that will be subjectively evaluated under asymmetric thrust conditions. For Level 7, this will be applicable only for those highly augmented airplanes in which flight test data verify the absence of motion without pilot input during the maneuver being accomplished. In the absence of this data for Level 7 and for all situations in Levels 1 - 6, these asymmetric thrust maneuvers are evaluated here only to verify that the procedures for the specific event may be accomplished satisfactorily. This evaluation does not imply that the maneuver itself, or the demonstration of proficiency in the application of the procedures, may be accomplished in any vehicle other than an appropriately qualified simulator or the airplane.

## TABLE OF FUNCTIONS AND SUBJECTIVE TESTS

*KEY:* 1 - Test. 2 - Level. 3 - Comments

### 1. FUNCTIONS AND MANEUVERS

a. PREPARATION FOR FLIGHT

1 - (1) Preflight. Accomplish a functions check of all installed switches, indicators, systems, and equipment at all crewmembers' and instructors' stations, and

determine that the cockpit or flight deck area design and functions replicate the appropriate airplane. 2 - 2, 3, 4, 5, 6, 7. 3 - For Levels 2 and 3 cockpit flight deck area design and functions must be representative of the appropriate set of airplanes.

b. SURFACE OPERATIONS (PRETAKEOFF)

1 - (1) Engine start.. (i) Normal start.. (ii) Alternate start procedure.. (iii) Abnormal starts and shutdowns (hot start, hung start, etc.). 2 - 2*, 3, 4*, 5*, 6, 7. 3 - * If appropriate to installed systems.

1 - (2) Pushback.. 2 - 3, 4*, 5, 6, 7. 3 - * If appropriate to installed systems.

1 - (3) Thrust response.. 2 - 2, 3, 5, 6, 7

1 - (4) Power lever friction.. 2 - 2, 3, 5, 6, 7

1 - (5) Brake operation (normal and alternate/emergency).. 2 - 2*, 3, 5*, 6, 7. 3 - * If appropriate to installed systems.

1 - (6) Brake fade (if applicable).. 2 - 7.

1 - (7) Other.

c. TAKEOFF

1 - (1) Normal.

1 - (i) Powerplant checks (engine parameter relationships).. 2 - 2*, 3, 4*, 5*, 6, 7. 3 - * If appropriate to installed systems.

1 - (ii) Acceleration characteristics.. 2 - 2*, 3, 5*, 6, 7. 3 - * If appropriate to installed systems.

1 - (iii) Nose wheel and rudder steering.. 2 - 2*, 3, 5*, 6, 7. 3 - * If appropriate to installed systems.

1 - (iv) Effect of crosswind.. 2 - 2, 3, 5, 6, 7

1 - (v) Special performance.. 2 - 5, 6, 7

1 - (vi) Instrument.. 2 - 2, 3, 5, 6, 7

1 - (vii) Landing gear, wing flap leading edge device operation.. 2 - 2*, 3, 5*, 6, 7. 3 - * If appropriate to installed systems.

1 - (viii) Other.

1 - (2) Abnormal/Emergency.

1 - (i) Rejected. 2 - 3, 6, 7

1 - (ii) Rejected special performance.. 2 - 3, 6, 7

1 - (iii) With failure of most critical engine at most critical point along takeoff path (continued takeoff).. 2 - 7. 3 - Applicable only to those highly augmented airplanes in which flight test data verify absence of motion without pilot input during this maneuver.

1 - (iv) Flight control system failure modes.. 2 - 2, 3, 4, 5, 6, 7. 3 - If appropriate for the airplane and the installed systems.

1 - (v) Other.

d. INFLIGHT OPERATION

1 - (1) Climb.

1 - (i) Normal. 2 - 2, 3, 5, 6, 7

1 - (ii) One engine inoperative procedures.. 2 - 2, 3, 5, 6, 7

1 - (iii) Other.

1 - (2) Cruise.

1 - (i) Performance characteristics (speed vs power). - 2, 3, 5, 6, 7

1 - (ii) Turns with/without spoilers (speed brake) deployed.. - 2, 3, 5, 6, 7

1 - (iii) High altitude handling.. - 2, 3, 5, 6, 7

1 - (iv) High speed handling.. - 2, 3, 5, 6, 7

1 - (v) Mach effects on control and trim, overspeed warning.. - 2, 3, 5, 6, 7. - If appropriate to the airplane or set of airplanes.

1 - (vi) Normal and steep turns.. - 2, 3, 5, 6, 7

1 - (vii) Performance turns.. - 2, 3, 5, 6, 7

1 - (viii) Approach to stalls, that is stall warning (cruise, takeoff/approach, and landing configuration).. - 2, 3, 5, 6, 7

1 - (ix) High angle-of-attack maneuvers (cruise, takeoff/approach, and landing).. - 2, 3, 5, 6, 7

1 - (x) In-flight engine shutdown.. - 2*, 3, 4*, 5*, 6, 7. - * If appropriate to installed systems.

1 - (xi) In-flight engine restart.. - 2*, 3, 4*, 5*, 6, 7. - * If appropriate to installed systems.

1 - (xii) Maneuvering with engine(s) inoperative.. - 2, 3, 5, 6, 7. - Level 7 - Applicable only to those highly augmented airplanes in which flight test data verify the absence of motion without pilot input during this maneuver. In the absence of this data for Level 7 and for Level 6 and below, this test is accomplished only to verify that the procedures for this situation or condition can be accomplished satisfactorily.
1 - (xiii) Specific flight characteristics.. 2- 6, 7
1 - (xiv) Manual flight control reversion. 2 - 6, 7. 3 - If appropriate for the airplane.
1 - (xv) Flight control system failure modes.. 2 - 6, 7
1 - (xvi) Other.
1 - (3) Descent
1 - (i) Normal.. 2 - 2, 3, 5, 6, 7
1 - (ii) Maximum rate.. 2 - 2, 3, 5, 6, 7
1 - (iii) Manual flight control reversion. 2 - 6, 7
1 - (iv) Flight control system failure modes.. 2 - 6, 7
1 - (v) Other.
e. APPROACHES
1 - (1) Non-precision.
1 - (i) All engines operating. 2 - 2, 3, 5, 6, 7
1 - (ii) One or more engines inoperative. 2 - 3, 6, 7. 3 - Level 7 - Applicable only to those highly augmented airplanes in which flight test data verify the absence of motion without pilot input during this maneuver. In the absence of this data for Level 7 and for Level 6 and 3, this test is accomplished only to verify that the procedures for this situation or condition can be accomplished satisfactorily.
1 - (iii) Approach Procedures.. – NDB. -- VOR, RNAV TACAN. -- DME ARC. -- LOC/BC. -- LDA, LOC, SDF. – ASR. 2 - 2, 3, 5, 6, 7
1 - (iv) Missed approach.. 1 - -- All engines operating.. 2 - 2, 3, 5, 6, 7. 1 - -- One or more engines inoperative (as applicable).. 2 - 7. 3 - Applicable only to those highly augmented airplanes in which flight test data verify the absence of motion without pilot input during this maneuver.
1 - (2) Precision.
1 - (i) PAR - Normal. 2 - 3, 6, 7. 3 - As applicable.
1 - (ii) ILS. 2 - 2*, 3, 5*, 6, 7. 3 - As applicable. * Autocoupled approach procedures.
1 - (A) Normal.
1 - (B) Category I published: Manually controlled with and without flight director to 100 feet below published decision height.
1 - (C) Category II published: With use of autocoupler, autothrottle, and autoland, as applicable.
1 - (D) Category III published:
1 - (1) With electrical power, source failure. 3 - Tests accomplished with maximum and crosswind authorized if less than 10 knots.
1 - (2) With 10 knot tailwind.
1 - (3) With 10 knot crosswind.
1 - (iii) MLS. 2 - 3, 6, 7. 3 - As applicable.
1 - (A) Normal.
1 - (B) Steep glideslope.
1 - (iv) Effects of crosswind. 2 - 2, 3, 5, 6, 7. 3 - As applicable.
1 - (v) With engines inoperative. 2 - 2, 3, 5, 6, 7. 3 - Level 7 - Applicable only to those highly augmented airplanes in which flight test data verify the absence of motion without pilot input during this maneuver. In the absence of this data for Level 7 and for Level 6 and below, this test is accomplished only to verify that the procedures for this situation or condition can be accomplished satisfactorily.
1 - (vi) Missed approach.
1 - (A) Normal. 2 - 2, 3, 5, 6, 7. 3 - As applicable.
1 - (B) With engines inoperative. 2 - 2, 3, 5, 6, 7. 3 - Level 7 - Applicable only to those highly augmented airplanes in which flight test data verify the absence of motion without pilot input during this maneuver.

In the absence of this data for Level 7 and for Level 6 and below, this test is accomplished only to verify that the procedures for this situation or condition can be accomplished satisfactorily.

f. SURFACE OPERATIONS (POST LANDING)

1 - (1) Landing roll.

1 - (i) Spoiler operation. 2 - 2*, 3*, 5*, 6, 7. 3 - * If applicable to installed systems.

1 - (ii) Reverse thrust operation. 2 - 3, 6, 7

1 - (iii) Other.

g. ANY FLIGHT PHASE

1 - (1) Aircraft and powerplant systems operation.

(i) Air conditioning.
(ii) Anti-icing/deicing.
(iii) Auxiliary powerplant.
(iv) Communications.
(v) Electrical.
(vi) Fire detection and suppression.
(vii) Flaps.
(viii) Flight controls (including spoiler/speed brake).
(ix) Fuel and oil.
(x) Hydraulic.
(xi) Landing gear.
(xii) Oxygen.
(xiii) Pneumatic.
(xiv) Powerplant.
(xv) Pressurization.
2 - 2, 3, 4, 5, 6, 7
3 - If applicable to installed systems.

1 - (2) Flight management and guidance systems.

(i) Automatic landing aids.
(ii) Automatic pilot.
(iii) Thrust management/autothrottle.
(iv) Flight data displays.
(v) Flight management computers.
(viii) Stall warning/avoidance.
(vi) Flight director/system displays.
(A) Head down.
(B) Head up.
(vii) Navigation systems.
(ix) Stability and control augmentation.
(x) Other.2 - 2, 3, 4, 5, 6, 7. 3 - If applicable to installed systems.

1 - (3) Airborne procedures.

(i) Holding.
(ii) Other. 2 - 2, 3, 4, 5, 6, 7. 3 - If applicable to installed systems.

1 - (4) Engine shutdown and parking.

(i) Systems operation.
(ii) Parking brake operation. 2 - 2, 3, 4, 5, 6, 7. 3 - If applicable to installed systems.

1 - (5) Other.

# APPENDIX 4
# EXAMPLES

## FIGURE 1. APPLICATION LETTER

Operator Name ___________________ Airlines
Address

Dear Mr. ___________,

(Operator Name) requests evaluation of our (Type) airplane flight training device for qualification at Level _______. The (Operator Name) flight training device is fully defined on page ____ of the accompanying approval test guide (ATG). We have completed tests of the flight training device and certify that it meets all applicable requirements and the guidance of Egyptian Advisory Circular (EAC) 121-1. Appropriate hardware and software configuration control procedures have been established. Pilots we have designated as our representatives have assessed the flight training device and we concur with their finding that it conforms to the (Operator Name) (Type) airplane cockpit configuration and that the simulated systems and subsystems function equivalently to those in the airplane. These pilots have also assessed the performance and flying qualities of the flight training device and we concur with their finding that it represents the respective airplane.
(Added comments as desired.)

Sincerely,

---------------------------------------------------------------------------

## FIGURE 2. EXAMPLE ATG COVER PAGE

(OPERATOR NAME)
(OPERATOR ADDRESS)

ECAA APPROVAL TEST GUIDE
(AIRPLANE MODEL)
(Level of Flight Training Device)
(Training Device Identification Including Manufacturer, Serial Number)
(Location)

ECAA Initial Evaluation
Date: ________________
(Operator Approval) Date: ______
___________________ Date: ______
ECAA/FSSS,

---------------------------------------------------------------------------

## FIGURE 3. INFORMATION PAGE

OPERATOR
OPERATOR DEVICE CODE: MTD-441 #1
AIRPLANE MODEL: MTD-441-B
AERODYNAMIC DATA REVISION: MTD-441-B CPX-8D July 1988
ENGINE MODEL AND REVISION: CPX-8D-RPT-1 June 1988
FLIGHT CONTROLS DATA REVISION: MTD-441-B May 1988
FLIGHT MANAGEMENT SYSTEM: Berry XP
TRAINING DEVICE MODEL AND MANUFACTURER: MFD-7X Tinker
DATE OF MANUFACTURE: 1988
COMPUTER: CIA