ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
Washington, D.C.

FAR GUIDANCE MATERIAL

Subject: AIRCRAFT SIMULATOR AND VISUAL SYSTEM EVALUATION AND APPROVAL

1. PURPOSE. This advisory circular sets forth one means that would be acceptable to the Administrator for approval of aircraft simulators requiring approval under Section 121.407 and Appendix H to Part 121 of the Federal Aviation Regulations (FAR).

2. CANCELLATION. AC 121-14B, Aircraft Simulator And Visual System Evaluation and Approval, dated October 16, 1978, is canceled.

3. BACKGROUND. As the state-of-the-art in simulator technology advances, more effective use has been made of the aircraft simulator in both training and checking of flight crewmembers. The increasing complexity and operating costs of the modern turbojet and its operating environment point to greater use of the advanced technology now available in aircraft simulators. Simulators can provide more in-depth training than can be accomplished in the aircraft. There is also a very high percentage of transfer of learning from the simulator to the aircraft. The additional use of simulators, in lieu of the aircraft, results in safer flight training, great cost reductions for the operator, and achieves the benefit of fuel conservation and a decrease in noise pollution. During the last 10 years, as simulator technology has improved, changes to the FAR were made to permit the increased use of simulators in air carrier training programs. In the late 1960's, visual attachments appeared on the market. Since that time, a breakthrough in computerization has permitted the development of computer-generated image visual systems. In December 1973, FAR Amendments 61-62 and 121-108 permitted additional use of visual simulators. Amendments to § 121.439 of the FAR permitted a simulator approved for the landing maneuver to be substituted for the aircraft in a pilot recency of experience qualification. These changes to the FAR constituted a significant step toward the development of Amendments 61-69 and 121-161 issued June 24, 1980, which contain the FAA Advanced Simulation Plan.

4. SCOPE OF APPROVAL. The approval criteria and procedures described in this circular apply to requests for approval of aircraft simulators under Section 121.407 and Appendix H to Part 121.

5. DEFINITIONS.

a. An Aircraft Simulator is a device which duplicates a specific aircraft's cockpit and is capable of closely representing the actual aircraft through various ground and flight regimes. The evaluation and approval of aircraft simulators should be conducted in accordance with this advisory circular. For the purpose of this circular and FAR 21.407, any device which does not meet the aircraft simulator provisions set forth herein should be considered a training device.

b. Simulator Data includes 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 provide aircraft data to the simulator manufacturer, which in the case of aircraft not yet flying will be predicted data. In the case of aircraft already flying, data obtained from the airplane flight manual, aircraft type inspection report, or actual aircraft flight test data should be used. The data should be applicable to the specific aircraft and should be acceptable to the Administrator. For a new type of aircraft, predicted data validated by actual aircraft flight test data, which has not received final approval by the manufacturer, can be used for an interim period as determined by the Administrator. In the event predicted data are used in programming the simulator, it should be updated as soon as practicable when actual aircraft flight test data becomes available.

c. Flight Test Data are aircraft performance tests electronically recorded in flight and verified as accurate by the company performing the flight test. Other data such as photographic data, will be considered flight test data after evaluation by the National Simulator Program Manager and approval by the Principal Operations Inspector (POI). For new generation aircraft issued an original type certificate after June 1, 1980, only manufacturer's flight test data should be accepted for initial approval. Exceptions to this policy must also be submitted to the NSPM for review and consideration.

d. The Customer Acceptance Test Guide is a group of simulator tests agreed to by a simulator manufacturer an its customer to verify the simulator's performance against the customer's simulator design specifications.

e. Approval Test Guide (ATG) is a document containing a group of tests required for FAA approval of the simulator. They are designed to verify that the functional and performance characteristics of the simulator agree with those of the airplane. This test guide is developed by an operator and presented to the FAA when the operator seeks approval of its simulator. Where aircraft data does not represent operational values (e.g. weight, configuration) additional tests at other values should be included in the ATG.

f. National Simulator Program Manager (NSPM) is the chairman of the National Simulator Evaluation Team an an AA expert on simulator approval.

g. National Simulator Evaluation Team is a group of FAA technical specialists especial rain to evaluate aircraft simulators and to provide expertise on matters concerning aircraft simulation within their respective regions.

6. EXTENT OF SIMULATOR APPROVAL. There are five levels of aircraft simulators; no , , an ass , I, and III, with Phase III simulators being the most sophisticated. The more sophisticated the simulator the more training and checking may be approved for that simulator. The maximum mount of training and checking which may be approved for a simulator is described in Appendix A to Part 61 and Appendixes E and F to Part 121 for the nonvisual and visual simulators and Appendix H to Part 121 for the Phase I, II, and III simulators. The amount of training and checking actually approved depends upon the operator's training program and the results of initial and recurrent simulator evaluations described in this advisory circular. Procedures for applying for approval of an aircraft simulator are identical for each level of simulator, but simulator requirements become more stringent at higher levels of sophistication. A simulator will be approved at the highest level for which it will qualify within the context of the operator's training program.

7. SIMULATOR EVALUATIONS.

a. In order to ensure an adequate transfer of learning from the simulator to the aircraft, the simulator must be evaluated in each of the areas critical to the accomplishment of the training. This includes evaluating the simulator's fidelity in directional, longitudinal, and lateral control and capabilities in the areas of preflight, control checks, taxi, takeoff, climb, cruise, descent, approach, landing, and certain additional requirements depending on the level of sophistication of the simulator. The simulator's motion system, visual system, and instructor's console also need to be evaluated to ensure their proper operation.

b. It is desirable to evaluate the simulator as objectively as possible. However, due to time constraints in conducting the evaluation and the large amount of flight test data which would be necessary, it is not feasible to evaluate the .simulator totally objectively. Therefore, evaluation of an aircraft simulator involves two types of tests designed to show that the device can simulate the aircraft with sufficient fidelity to conduct the amount of training or checking requested by the operator in the simulator. These tests include functional tests, which are subjective evaluations conducted by an FAA pilot type rated in the aircraft, and performance tests, which are objective tests which demonstrate that the simulator has aerodynamic and ground handling characteristics analogous to the aircraft simulated. Functional tests must show that a pilot who is type rated in the airplane can accomplish all of the critical training areas within the pilot performance standards; required to pass an airline transport pilot (ATP) type rating check in the aircraft. Performance tests are designed as an to-depth evaluation of critical training areas. They objectively compare simulator and aircraft performance within a specified performance tolerance.

c. Each of the two types of tests is designed to complement and corroborate the other and be supportive of required training objectives. Both types of tests are essential for approval of all aircraft simulators. If a problem with the simulator is detected; by the National Simulator Evaluation Team in either a functional or performance test, the test will be examined by reviewing additional

flight test data. If the problem is confirmed, the team will inform the POI who will advise the operator that corrective action must be taken to include, as appropriate, modification, replacement, or repair of defective components or an amendment to the simulator's programming. After correction of a verified problem, the simulator should be retested by the team until all functional and performance tests are satisfactorily completed. Except as provided in paragraph 5.b. of this advisory circular as it relates to new aircraft types, all Phase I, II, and III programming modificatirns will be based on actual aircraft flight test data which can be objectively measured in a performance test. Nonvisual and visual simulator programming will be based on the best data available.

d. Appendix 1 of this advisory circular describes the ®eneral simulator and visual system requirements, Appendix 2 describes functional tests, and Appendix 3 describes the perform$nce tests to be accomplished for simulator approval. The. operator should providean-M which describes each test listed in Appendix 3, the parameters to be recorded, how the test is to be performed, the test tolerances, and actual flight test data with the simulator's performance data collected during the operator's verification tests cross-plotted over the flight test data to show proof of performance. (See Appendix 4 for example:) The data sheet containing the flight test data *shown* in Appendix 4 has been reduced in this advisory circular for editorial purposes and has been included for clarification. Aircraft data included *in an ATG* may be reduced only if the reduction will not alter the graphic scaling or cause difficulties in scale interpretation. The original multichannel reeordingg collected during the evaluation process should be submitted with the master ATG under separate cover.

e. Performance tolerances listed in Appendix 3 should not be confused with design tolerances specified for simulator manufacture. Performance tolerances are *maximum* tolerances to ensure satisfactory transfer of learning. If these tolerances are exceeded, evaluation and training shall not be conducted on the simulator except as described in the *minimum* equipment list.

f. For a simulator to retain its approval it will be evaluated on a recurring basis. The recurring evaluation will be accomplished every 4 months by the FAA National Simulator Evaluation Team. It will consist of approximately 1/3 of the functional and performance tests so that the simulator is totally reevaluated annually. Between recurring evaluations, if deficiencies are discovered or it becomes apparent that the simulator is not being maintained to the tolerance for which the simulator was initially approved, the National Simulator Evaluation Team will conduct a special evaluation) of the simulator to confirm its performance. Simulator approval will remain in effect until the National Simulator Evaluation Team makes a final determination based on the special evaluation.

g. If, after initial approval, there appears to be a problem in a functional test area, and the associated performance test in the ATG meets the prescribed tolerances, and the problem is verified by a member of the National Simulator Evaluation Team, the operator will be given 30 days to produce additional performance tests to verify the simulator's fidelity in the area of concern. The National Simulator Evaluation Team will then conduct a special evaluation and make a determination regarding the simulator's status based on the results of those additional performance tests.

8. PROCEDURES FOR SIMUIATOR APPROVAL.

a. Operators desiring approval for a simulator must submit their request in writing to the POI. This request should contain a statement certifying that the simulator has successfully completed each test in the operator's ATG, that the simulator meets all of the specifications of this advisory circular, and that the pilot(s) designated by the operator confirm that it is representative of the airplane in all functional test areas. Operators are advised that if the National Simulator Evaluation Team determines that the simulator does not perform to the level certified by the operator, and that the problem cannot be corrected without causing delays in the evaluation, the evaluation will be terminated and the team members returned to their duty stations. However, depending on the nature and extent of the problem, the team may elect to approve the simulator at the status requested or at a lesser status than requested by the operator until such time as the problem is resolved to the satisfaction of the NSPM and POI.

b. A copy of the operator's ATG should accompany the request. Appendix 4 of this advisory circular illustrates an example of one test that might be included in an ATG. It is provided to illustrate a standard format acceptable to the Administrator. Variations in format will be permitted as long as the same information is contained in the operator's test guide.

c. The ATG should include the following:

(1) The tests and procedures for conducting the tests described in Appendix 3 of this advisory circular or their equivalent.

(2) For Phase I, II, or III simulators, manufacturer's flight test data or other approved data to verify each aerodynamic test. Data derived from sources other than the aircraft manufacturer must be certified by the operator and approved by the POI after review by the NSPM. For nonvisual and visual simulators, the best data available should be utilized. This should include flight test data, FAA--approved flight manual data, or simulator probing data in that order of preference.

(3) The operator's results of conducting the simulator tests should be recorded on a multichannel recorder, line printer, or other acceptable means. These results should be cross-plotted onto the aircraft flight test data. The test glide will then show the documented proof of compliance with the simulator performance requirements of Appendix H to Part 121. Simulator multichannel recorders capable of developing graphs in the same scale as the flight test data need not be cross-plotted onto the flight test data, but should be marked with reference points for easy alignment on the data. For tests involving time histories, flight test data sheets and multichannel recordings should be clearly marked with appropriate reference points to show where the operator entered the flight test data when cross-plotting the simulator data. Operators using line printers to record time histories should clearly mark that information taken from the line printer data sheet for cross-plotting in the aircraft. Evaluations of nonvisual and visual

simulators, which were not originally equipped with a *multichannel* recorder interface capability, should be evaluated by the most practicable alternate means available. Several test paints should be checked to verify simulator performance as compared to the aircraft.

(4) All flight test data or other verification data submitted for each test should be to an incremental scale which is easily comparable to the tolerances shown in Appendix *3* of this circular for that test.

d. Upon receipt of a request for Phase I, II, or III approval, the POI should review the ATG to ensure that all of the tests in the ATG have been accomplished by the operator and the results have been cross-plotted or overlayed on to the flight test data. The original hard copies of the multichannel recorder printouts should be inserted into a separate volume referencing the master ATG test. Simulator and flight test data, which are obviously not necessary to accomplish the purpose of the test, need not be cross-plotted. The cross-plotting of the operator's simulator tests is essential to verify simulator performance of each test so that the National Simulator Evaluation Team can devote their time to detailed checking of selected tests from the ATG. The FAA evaluation will therefore serve to validate the operator's simulator tests.

e. If the ATG meets the requirements of this circular, the POI should write a cover letter stating that the ATG has been reviewed and complies with the guidance contained in this circular. The letter and the material submitted by the operator should then be forwarded to the NSPM for review.

f. Within 10 working days of receiving the ATG, the NSPM will coordinate with the FOI to set a mutually acceptable date for the evaluation. A local inspector who is rated in the aircraft being simulated and familiar with the operator's training program may assist the team's initial evaluations, if desired by the POI.

g. Due to the time required for each evaluation, some delay could occur in initial evaluations. In the event of scheduling conflicts, evaluations will be conducted in the same sequence as the ATG and evaluation requests are received by the NSPM. Immediately following an evaluation, the National Simulator Evaluation Team will remain at the operator's facility to participate with the operator in plotting the data from the simulator evaluation on to the aircraft flight test data scarce or other sources approved by the Administrator. The- team will then recommend interim approval or disapproval of the simulator to. the POI based on its findinga. However, final approval will not be granted until the master ATG has been reviewed by the NSPM. The ATG is an important aspect in the final approval process. Operators should understand that final approval will only be granted when the ATG meets or exceeds the standards of this advisory circular.

h. The completed master ATG should contain the following format: Table of contents; reference page listing all verification data used; glossary of terms and symbols used in the test guide; and for each test included in tke test guide, the *name* of the test, the test objective, the test conditions and the test procedures, the recording procedure, the tolerances allowed, and the flight test data with the operator and FAA evaluation results cross-plotted on that data as shown in Appendix 4.

i. The original multichannel recording or line printer data of the operator's evaluation and the FAA's evaluation should be submitted along with the master ATG under separate cover. The multichannel recording or line printer data should be presented in a manner that is easily cross-referenced to the data in the test guide.

The POI will forward the master ATG, a copy of the master ATG, and the original multichannel recordings to the NSPM for final review. The NSPM will then return the master ATG and the multichannel recording to the POI for approval. This material will remain on file at the FAA district office for use in recurrent simulator evaluations.

k. All simulator initial approvals and subsequent recurring evaluations after the date of this circular will be evaluated according to the gaidence herein. Nonvisual and visual simulators will retain their original approvals as long as the simulator is operated by the same operator and is maintained to the same tolerances for which it was initially approved. Simulators previously approved for the landing maneuver prior to issuance of this circular are considered to be Phase I simulators.

9. CHANGES TO SIMULATOR PROGRAMMING. While a need exists for some flexibility in making changes n he software program, strict scrutiny of these changes is. essential to ensure that the simulator retains its ability to duplicate the airplane's flight and ground characteristics. Therefore, the following procedure must be followed to allow these changes without affecting the approval of an Appendix H simulator:

a. Twenty-one calendar days before making changes to the software program which might impact flight or ground dynamics of an Appendix H simulator, a complete list of these planned changes, including dynamics related to the motion and visual. systems, must be provided, in writing, to the POI who will forward the proposed changes to the National Simulator Evaluation Team specialist assigned to that region for review.

b. If the FAA does not object to the planned change within 21 calendar days of receipt by the FAA, the operator may make the change.

c. Changes which might affect the approved simulator Phase I ATG must be tested by the operator in the simulator to determine the impact of the change before submission to the FAA.

d. Software changes actually installed must be summarized and provided to the FAA. When the operator's test shows a difference in simulator performance dale to a change, an amended copy of the test gaide page, *which* includes the new simulator test results, will also be provided to update the FAA's master test guide and copy of the test guide.

e. The FAA meq examine supporting data or flight check simulator or both to ensure that the aerodynamic quality of the simulator has not been degraded by any change in software programming.

f. All requests for charges are evaluated on the basis of the same criteria used in the initial approval of the simulator for Phase I, II, or III.

10. SIMULATOR MINIIKUM DQUIPMENT LIST (MEL). Hecanse of the strict tolerances and other approval requirements ppendix simulators, the simulator can provide realistic training with certain nonessential items inoperative. Therefore, an operator mqy operate its simulator under an MEL *which* has been approved by the Administrator for that-simulator. FAR Section 121.407 requires that approved airplane simulators maintain, on a contim=s basis, the performance, functional, and other characteristics that are required for initial approval. This basically requires all simulator components which impact on training to operate all of the time. Prior to this advisory circular, guidelines regarding what would be the minimum acceptable standards for inoperative simulator equipment have not existed. During the development of the Advanced Simulation Regilaticn it became apparent that an MEL would be of substantial benefit,by allowing a simulator to continue to be used to the greatest extent possible.

a. While the MEL referenced in Appendix H to Part 121 is permissive in nature, the development of an MEL will allow an operator to continue to utilize the simulator *when* an inoperative component would not affect the training being conducted. Therefore, it is to the advantage of the operator to develop an MEL for each of its simulators, including visual and nonvisual simulators. The MEL should include each significant simulator component and indicate the type of training or checking that is authorized if that component becomes inoperative. To accomplish this, the component is placed in one at the following categories along with arty remarks applicable to the component's use in the training program. Further subcategorization (e.g., PLC, SIC, FE, etc.) will be acceptable.

(1) No training or checking.

(2) Training in specific maneuvers.

(3) Certification and checking.

(4) Line Oriented Flight Training (LOFT).

b. If an inoperative component in the MEL would preclude operation of the simulator under the Phase for which it was approved, the simulator could still be utilized for training within its limitations. For example, if the visual system were to become inoperative on a Phase II simulator, the MEL could indicate that the simulator could still be operated as a nonvisual simulator for training as authorized by Appendix E to Part 121. However, the simulator would maintain its Phase II classification and the MEL would continue to govern its operations. Due to the complexity of developing a comprehensive MEL, a simulator master minimum equipment list (SMMEL) will be developed. MEL's for simulators should be submitted within 1 year of the initial approval of the SMMEL. Simulator MEL's shaild be submitted to the POI who will review them in conjunction with the regional simulator evaluation specialist. The proposed MEL will then be forwarded to the NSPM for final review prior to approval by the POI.

11. ADVANCED StMATION TRAINING PROGRAM. For an operator to conduct Phase II, IIA, or rah ng under Appendix , required simulator instruction and checks must be conducted under an Advanced Simulation Training Program which is approved by the AdministraTor for the operator. This program must also ensure that all instructors and check airmen used in Appendix H training and checking are highly qualified to provide the training required in the training program. As shown in Appendix H to Part 121, there are seven areas which must be included in the Advanced Simulation Traiining Program. The POI is responsible for approving these programs. Area number 2 in Appendix H (how the training program will integrate simulators and training devices to maximize total training) must be reviewed by the NSPM prior to initial training program approval by the POI. The following provides additional guidance in each area required in the Advanced Simulation Training Program:

a. Each operator must submit the operator's initial, transition, upgrade, and recurrent simulator training programs and its procedures for reestablishing recency of experience in the simulator. For operators who do not have previously approved simulator training programs, 20 hours is considered the minimum simulator time required for initial approval of initial, transition, and upgrade training for each pilot in commend under the Advanced Simulation Training Program. This 20-hour requirement may be reduced under the provisions of FAR Section 121.405 after the operator has demonstrated that such a reduction is justified. The 20 hours is in addition to the requirement for the 4 hours of IAFT training required under Phases II, IIA, and. III. Operators currently having an approved simulator training program for any pilot position may continue utilizing the same number of simulator hours and substituting Phase II, IIA, or III simulator training for the average airplane training time on a two for one basis not to exceed the number of hours required by Section 121.424 (20 hours pilot in command, 10 hours second in command). When calculating the required simulator time in lieu of airplane time, the average airplane time utilized under the old training program should be multiplied by two and then rounded to the nearest whole hour. For example, an operator who has a previously approved initial training program which includes an average of 15 hours of simulator time and 2 hours of airplane time (1 .3 hours for training and .7 hours for the check) would submit an initial training program under the Advanced Simulation Plan consisting of 18 hours (1 .3 x 2 = 2.6 = 3 hours + 15 = 18 hours) of simulator time. This 18 hours would include the time required for the check. Operators should submit the basis used to calculate average times under their old program. Four hours of LOFT training would follow the simulator certification and proficiency check prior to beginning line operating experience in the airplane. The Phase IIA line operating experience required in Appendix H to Part 121 is not to be considered an additional requirement over the operating experience requirements of FAR Section 121.434. However, all of the operating experience flight-hours prescribed in Appendix H are required and may not be reduced as otherwise provided for in Section 121.434(f) of the FAR.

b. Each operator must show how the training program will integrate Phase I, II, and III simulators with other simulators and training devices to maximize the total training, checking, and certification functions. As a minimum, each pilot should be trained to proficiency in each Part 121, Appendix E, maneuver that appears in either the visual simulator or in-flight columns of Appendix E in the appropriate Appendix H simulator prior to the check. The entire qualification/certification check and the IAFT period following the check must be conducted in a Phase I, II, or III simulator, as appropriate.

c. Each operator must submit documentation that each instructor and check airman has been employed by. the certificate holder for at least 1 year in that capacity or as a pilot in command or second in command in an airplane of the group in which that person is instructing or checking.

d. Each training program must include a procedure to ensure that each instructor and check airman actively participates in either an approved regularly scheduled line flying program as a flight crewmember or an approved line observation program in the same airplane type for which that person is instructing or *checking.* Under the Advanced Simulation Plan, a minimum of three legs on the line in the preceding consecutive 90-day period should be considered the minimum requirement for active participation for check airmen or instructors and, for simulator instructors, a minimum of 3 hours per quarter should be considered minimum active participation for the line observation program.

e. Each training program must include a procedure to ensure that each instructor and check airman is given a minimum of 4 hours of training each year to become familiar with the operator's Advanced Simulation Training Program, or changes to it, and to emphasize their respective roles in the program. Training for simulator instructors and check airmen shall include training policies and procedures, instruction methods and techniques, and, except for line check *airmen,* operation of simulator controls (including environmental and trouble panels), limitations of the simulator, and minimum equipment required for each course of training. The 4-haur training course required for line check airmen under Phase IIA may run concurrently with, and is not considered in addition to, this 4•-hour training requirement. Additionally, to ensure that the line check airman is trained to react to any pilot proficiency problem that may be detected during the operating experience, a line check airman who conducts line operating experience should have received the training required by FAR Section 121.413(c). The exclusions stated in 121.411(c) still apply.

f. Each operator must submit a special Line Oriented Flight Training (LOFT) program to facilitate the transition from the simulator to line flying. This LOFT program consists of at least a 4-hour course of training for each flightcrew. It also contains at least two representative flight segments of the operator's route. One of the flight segments contains strictly normal operating procedures from push beck at one airport to arrival at another. Another flight segment contains training in appropriate abnormal. and emergency flight operations; for example, in-flight diversions due to adverse weather or an engine fire. Under this special LOFT program the trainee should be in the crew position for which he/she is qualifying. Other positions may be filled by any other person qualified to acct in that position. The 4-haur requirement exists regardless of the number of crew positions occupied by trainees during the LOFT period. If two pilot trainees are occupying both pilot positions, the operation of the controls should be evenly divided between the pilots. Guidelines associated. with LOFT programs conducted under the provisions of FAR 121.409 need not apply to this special LOFT program.

g. Operators training under Phase IIA must include the additional training requirements of that phase in their training programs. The completion of the requirements in Section 121.413(c) will satisfy the requirements of the approved simulator check airman course for Phase IIA line check airmen who are not proficiency check qualified.

h. Advanced Simulation Training Programs should be submitted to the POI who will review the training program for initial approval and forward it with his/her comments and recommendations for final approval review to the NSPM. Subsequently, the POI will grant final approval to the training program or inform the operator of additional necessary action.

12. PHASE IIA - INTERIM SIMULATOR UPGRADE PLAN FOR PART 121 OPERATORS. Under Phase IIA, any Part 121 operator may conduct Phase training n a Phase simulator for 3 1/2 years from the date it was approved for Phase IIA. The operator must meet the additional requirements set forth below and submit a plan acceptable to the Administrator to upgrade its simulator(s) to meet Phase II standards. For an operator's upgrade plan to be acceptable, it must:

a. He submitted to the FAA before July 30, 1981;

b. Show which simulators will be upgraded to Phase I requirements and their projected upgrade dates;

c. Show that these simulators will meet Phase I requirements prior to January 30, 1983;

d. Show that at least 50 percent of the operator's simulators for those airplane types for which Phase IIA training is expected will be upgraded to, or to replaced with, simulators which meet Phase II or III requirements and:

(1) Show which simulators will be upgraded to, or replaced with, simulators which meet Phase II or III requirements; and

(2) Show that each of these simulators will meet Phase II or III requirements prior to 3 1/2 years of the date it is approved for Phase I; and

[These Appendix H requirements can be satisfied by a letter of intent signed by the appropriate corporate officer and should include any firm commitments that the company has made at the time of submission..]

e. Include an Advanced Simulation Training Program which meets the requirements of paragraph 11 of this advisory circular. The operator is not required to submit the entire training program with initial application under Phase IIA but should submit a training program description and outline which explains the trainiN program in sufficient detail to facilitate a valid evaluation of the Phase IIA plan. As a minimum, the outline should include the type of devices used, the amount of training time in each device, and what areas of training will be accomplished in each device. While the entire training program need not be submitted with the initial application, each training program will be reviewed in detail and approved by the POI prior to beginning Phase IIA training in that particular program. Phase IIA interim approval ends for each Phase I simulator listed in the operator's approved plan 3 1/2 years after that simulator is approved for Phase IIA training. Approval of the plan will be withdrawn if any simulator is not upgraded according tc the operator's approved simulator upgrade plan. This would result in the loss of all Phase IIA training for that operator. The operator's plan should be based on the best information available at the time. In the event implementation of element;

of the plan by the specified dates are delayed due to problems beyond the operator's control (e.g., parts delay, disasters, national emergency, etc.), the operator may petition for a modification of the plan. Periodic progress reports for the plan should be submitted to the POI for verification of adherence to the plan's time schedule. Extension of Phase IIA training will not be considered. Operators should submit their upgraded plains through their POI for review by the NSPM and subsequent approval by the POI.

13. **USE OF SIMULATORS IN THE ADVANCED SIMULATION TRADUNG PLAN.**

a. When using a Phase I, II, or III simulator for recency of experience, as required by Section 121.439 and for IAFT, the position freeze or repositioning features of the simulator should not be utilized in flight. For operators who normally operate lengthy route segments, a simulator may be repositioned during a LOFT period while in the cruise configuration at cruise altitude. These features will be used in rating/proficiency checks with utmost discretion.

b. Aircraft noise features *in* Phase I, II, and III simulators should be kept at levels representative of the airplane while *using* those simulators in the areas described in paragraph 13(a) of this advisory circular.

14. **INCRIIARITAL UPGRADE OF SIMULATORS.**

a. Operators should notify the POI of simulator hardware and programming changes which are necessary for the upgrading of a simulator to the next succeeding phase under the Advanced Simulation' Plan.

b. Depending on the nature and extent of such a change, the regional simulator evaluation specialist may elect to evaluate the simulator to determine the effect that the change makes re&rding the current phase under which the simulator is approved.

c. Changes to simulator hardware and programming, which are required for simulator upgrade, will not affect the current approval status of the simulator unless the evaluation in paragraph 14.b. above shows that the change has had a detrimental effect on the simulator.

15. **GRANDFATHER RIGATS.** **Section 121.407 of the FAR requires that simulators must maintain the** performance, **functional, and other characteristics that are** required **for approval. All initial approvals and** recurrent **evaluations of those simulators approved after the** effective **date of this advisory circular will therefore be** conducted in **accordance with the provisions** herein. **Simulators and visual systems approved prior to this advisory circular will continue to maintain their current approval as long as they meet the standards** under **which they were originally approved. Any transfer of a simulator from one operator to** another **or any simulator upgrade to Phase I, II, or III** standards requires **an initial evaluation of that simulator. Initial evaluations** conducted **after the** effective **date of this advisory circular should be** conducted in accordance **with the provisions** herein.

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APPENDIX 1. SIMULATOR AND VISUAL SYSTEM REQUIREMENTS

a. Discussion. For the convenience of the reader, the simulator and visual system requirements of Appendix H to Part 121 have been included in this appendix. Clarification has been included for some requirements. The preamble to the Advanced Simulation Rule contains additional guidance regarding these requirements.

b. Simulator Requirements - General.

(1) The cockpit should represent a full-scale mockup of the aircraft simulated. Where movement of controls and switches is involved, the direction of movement should be identical to that in the applicant's aircraft.

(2) Circuit breakers that affect procedures and functions resulting in observable cockpit indications should be functionally accurate.

(3) The effect of aerodynamic changes for various combinations of drag and thrust normally encountered in flight should correspond to actual flight conditions. The effect of change in aircraft attitude, thrust, drag, altitude, temperature, gross weight, center of gravity location, and configuration should be included.

(4) All relevant instrument indications involved in the simulation of the applicable aircraft should be entirely automatic in response to control movement by a crewmember.

(5) The rate of change of simulator instnument readings and of control forces should correspond to the rate of change which would occur on the applicable aircraft under actual flight conditions for arty given change in forces applied to the controls, in the applied power, or in aircraft configurations.

(6) Control forces and degree of actuation control travel should correspond to that which would occur in the aircraft under actual flight conditions.

(7) Communications and navigation equipment should correspond to that installed in the applicant's aircraft and should operate within the tolerances prescribed for the actual airborne equipment. Long range navigation systems should be installed but need not be operative unless required by Part 121, Appendix H.

(8) In addition to the flight crewmember stations, there should be two suitable seat accommodations for the Instructor/Check Airman and FAA Inspector. Operators who have the Check Airman/Instructor occupy a flightcrew position seat need only provide one additional observer seat. These seats should provide adequate vision to the pilot's panel and forward windows in visual system models. Observer seats need not represent the aircraft seats.

(9) Simulator systems should simulate the applicable aircraft system operation, both on the ground and in flight. Major systems should be operative to the extent that normal operating procedures, and abnormal and emergency procedures included in the operator's programs can be accomplished.

(10) An Instructor Control Console should be installed to enable the Instructor/Check Airman or FAA Inspector (when applicable) to control the visual attachment (if installed) and insert abnormal or emergency conditions into the aircraft systems.

c. Visual Requirements - General.

(1) The visual scene should accurately portray the environment equivalent to that which the pilot observes on the related simulator cockpit instrument display resulting from the manipulation of the controls and the effects of varying wind conditions.

(2) The visual displey may be either a monoview or duoview display. If a monoview display is used, it should be capable of transfer of display at either pilot station.

(3) The scene should comprise the airfield, surrounding area, airport ramp and taxiway.

(4) Representations of buildings or other outstanding features should be suitably detailed to produce a realistic effect on picture presentation.

(5) Functional airfield and approach lighting should be representative of the runway depicted with intensity controls to vary degree of lightness. Approach and runway, and lighting intensities should be independently variable. Realistic colors for approach, and runway lighting are required. Computer-generated image (CGI) systems should have the capability of portraying runway texture or surface.

(6) The aircraft landing lights should be operational.

(7) The optical system for Phase I and less sophisticated simulators should be capable of providing at least a 45° field of vision. Focus should be automatic in order to keep at optimum that part of the picture which is significant to the pilot. A minimum of 75° horizontally and 30° vertically is required for Phase II and III visual systems.

(8) An instructor's control should be provided to allow control of a]1 aspects of the visual system; i.e., cloudbase, visibility in miles and feet, airport selection, environmental lighting controls, VASI, etc.

(9) Visual systems approved for instrument takeoffs and/or instrument approach procedures should have a means of reducing visibility to reasonably simulate the appropriate weather conditions.

(10) Operators possessing visual systems that do not meet all the requirements contained in this paragraph and have received prior approval will have "grandfather rights." These systems will be eligible for continued approval for all maneuvers originally approved provided they are maintained to the level of acceptability demonstrated at original approval. The "grandfather rights" apply only to the original operator and are not transferable.

d. Simulator Requirements - Phase I.

(1) Aerodynamic programming to include:

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

(b) Ground reaction--reaction of the airplane upon contact with the runway during landing to include strut deflections, tire friction, and side forces.

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

(2) Minimum of 3-axis freedom of motion systems.

(3) Phase I landing maneuver test glide to verify simulator data with actual airplane flight test data, and provide simulator performance tests for initial approval.

(4) Multichannel recorders capable of recording Phase I performance tests.

e. Visual Requirements - Phase I.

(1) Visual system compatibility with aerodynamic programing.

(2) Visual system response time from pilot control input to visual system output shall not exceed 300 milliseconds more than the movement of the airplane to a similar input. Visual system response time is defined as the completion of the visual display scan of the first video field containing different information resulting from an abrupt control input.

(3) A means of recording the visual response time for comparison with airplane data.

(4) Visual cues to assess sink rate and depth perception during landings.

(5) Visual scene to instrument correlation to preclude perceptible lam.

f. Simulator Requirements - Phase II.

(1) Representative crosswind and three-dimensional windshear dynamics base on airplane related data.

(2) Representative stopping and directional control forces for at least the following runway conditions based on airplane related data:

(a) Dry.

(b) Wet.

(c) Icy.

(d) Patchy wet.

(e) Patchy icy.

Wet on rubber residue in touchdown zone.

(3) Representative brake and tire failure dynamics (including antiskid) and decreased brake efficiency due to high brake temperatures }hosed 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 1.oading and directional control characteristics should be representative of the aircraft.

(4) A motion system which provides motion cues equal to or better than those provided by a six-axis freedom of motion system.

(5) Operational principal navigation systems, including electronic flight instrument systems, INS, and CT+mGA, if applicable. This requirement is to enhance LOFT; therefore, if the operator's route structure requires dual long range navigation systems on board its aircraft (i.e. Omega, INS, Doppler) a sufficient number of simulators, but in no case less than one simulator, should be equipped with the appropriate long-range navigation system utilized.

(6) Means for quickly and effectively testing simulator programing and hardware. This could include an automated system which could be used for conducting at least a portion of the tests in the ATG.

(7) Expanded simulator computer capacity, accuracy, resolution, and dynamic response to meet Phase II demands. Resolution equivalent to that of at least a 32-bit word length computer is required for critical aerodynamic programs.

(8) Timely permanent update of simulator hardware and programing subsequent to airplane modificatioh.

(9) 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 noise, flap, gear and spoiler extension and retraction and thrust reversal to a comparable level as that found in the aircraft.

(10) 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. Airplane measurements may be obtained on the ground if proper pilot static inputs are provided to represent airspeeds typical of those encountered on takeoff, cruise and landing. This should provide control feel measurements comparable to those encountered in flight.

(11) 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 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 not occur before the resultant motion onset bpt within the system dynamic response tolerance of 150 milliseconds. The test to determine compliance

with these requirements shall include simultaneously recording the analog output from the pilot's control column and rudders, 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 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.

g. Visual Requirements - Phase II.

(1) Ihask and night visual scenes with at least three specific airport representations, including a capability of at least 10 levels of occulting, general terrain characteristics, and significant landmarks. It is not necessary for each airport scene to contain ten levels of occulting but there should be a means of demonstrating that the visual system has that capability.

(2) Radio navigation aids properly oriented to the airport runway layout.

(3) Test procedures to quidtly confirm visual system color, RVR, focus, intensity, level horizon, and attitude as compared to the simulator attitude indicator.

(4) For the approach and landing hale of flieht, at and below an altitude of 2,000 feet height above the airport (HAA~ and within a radius of 10 miles from the airport, weather representations including the following:

(a) Variable cloud density.

(b) Partial obscuration of ground scenes; that is, the effect of a scattered to broken cloud deck.

(c) Gradual break out.

(d) Patchy fog.

(e) The effect of fog on airport lighting.

(f) Category II and III weather conditions. These representations are required only if the operator is authorized to operate under Category II or III conditions.

(5) Continuous minimum visual field of view of 75' horizontal and 30° vertical per pilot seat. Visual gaps shall occur only as they would in the airplane simulated or as required by visual system hardware. Both pilot seat visual systems shall be able to be operated simultaneously.

(6) Capability to present ground and air hazards such as another airplane crossing the active runway or converging airborne traffic.

h. Simulator Requirements - Phase III.

(1) 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 ei®ulator must be programed 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 aliuospheric disturbances such as rough air and cobblestone turbulence. General purpose disturbance models that approximate demonstrable flight test data are acceptable.

(2) Aerodynamic modeling for aircraft for which an original type certificate is issued after June 1, 1980, including low-altitude, level-flight ground effect, mach effect at high altitude, effects of airframe icing, normal and reverse dynamic thrust effect on control surfaces, aero-elastic representations, and representations of nonlinearities due to side slip based on airplane flight test data provided by the manufacturer.

(3) Realistic amplitude and frequency of cockpit noises and sounds, including precipitation static and engine and airframe aeunds. The sounds shall be coordinated with the weather representations required in Phase TII visual requirement No. 3.

(4) Self-testing for simulator hardware end programing to determine compliance. with Phase I, II, and III simulator requirements.

(5) Diagnostic analysis printout of simulator malfunctions sufficient to determine *MEL* compliance. These printouts shall be retained by, the operator between recurring FAA simulator evaluations as part of the daily discrepancy log required under § 121.407(a)(5).

i. Visual Requirements - Phase III.

(1) Daylight, dusk, and night visual scenes with sufficient scene content to recognize a specific airport, the terrain, and major landmarks around that 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. For the purpose of this rule, 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 vroduced tp 4,000 edges or 1,000 surfaces for daylight and 4,000 light points for.aight and dusk scenes, 6-foot lamberts of light at the pilot's eye (highlight brightness), 3-are minutes resolution for the field of view at the pilot's eye, aria a display which is free of apparent quantization and other distracting visual effects while the simulator is in motion. The simulation of 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.

(2) Visual scenes portraying representative physical relationships which are known to cause landing illusions in some pilots, including short runway, landing over water, runway gradient, visual topographic features, and rising terrain.

(3) Special weather representations which include the sound, visual, and motion effects'of entering light, medium, and heavy precipitation near a thunderstorm on takeoff, approach, and landings at and below an altitude of 2,000 feet HAA and within a radius of 10 miles from the airport.

(4) Phase II visual requirements in daylight as well as dusk and night representations.

(5) Wet and, if appropriate for the operator, snow-covered runway representations, including runway lighting effects.

(6) Realistic color and directionality of airport lighting.

(7) Weather radar presentations in aircraft where radar information is presented an the pilot's navigation instruments.

APPENDIX 2. SIMULATOR FUNCTIONAL TESTS

a. Discussion. Functional tests are subjective tests of simulator characteristics and system operation evaluated from each flight crewmember position by a pilot rated in the aircraft simulated. As appropriate, these should include the cockpit check, system operation, normal, abnormal and emergency procedures using the operator's operating procedures and checklists. Arty shortcomingg in the equipment that would preclude realistic simulation of the procedure, maneuver, or system operation should be identified and compared to performance tests in the same area. The simulator evaluator should be able to accomplish all maneuvers in the simulator within the pilot performance standards required to pass an ATP training check in the aircraft.

b. Simulator Functional Tests. The ground and flight maneuvers which will be evaluat , as appropriate o e of aircraft, are discussed below.

(1) ~Prefligit. Accomplish a thorough preflight of all switches, indicators, and systems at all crewmembers' and instructor's stations, and determine that the cockpit design is identical to that of the aircraft simulated.

(2) Engine Start.

(a) Normal start.

(b) Alternate start procedures.

(c) Abnormal and emergency procedures during start.

(3) Taxi.

(a) Thrust response.

(b) Ground handling.

(c) Brake operation.(normal and alternate/emergency).

(d) Abnormal. and emergency procedures associated with ground operations.

Takeoff and Climb.

(a) Powerplant checks (engine parameter relationships).

(b) Acceleration characteristics.

(c) Nose wheel and rudder steering.

(d) Rejected takeoff.

(e) Normal takeoff.

(f) Takeoff with engine failure at critical engine failure speed.

(g) Crosswind takeoff (maximum which has been demonstrated).

(h) Instrument takeoff.

(i) Landing gear, flap, leading edge device oper4ion.

(j) Area departure.

(k) Climb performance - normal and engine/engines out.

(1) Abnormal and emergency procedures associated with takeoff and climb.

(m) Minimum control speed (one and, in the case of three- and four-engine aircraft, two engines inoperative).

NOTE: During the preceding checks, particular attention should 5e paid to rotation characteristics, handling characteristics, and rudder forces required with engine inoperative.

(5) Cruise.

(a) Performance characteristics (speed vs. power).

(b) Turns with/without spoilers.

(c) High speed buffet/mach tuck, overspeed warning.

(d) Normal and steep turns.

(e) Approach to stalls (stall warning, buffet and "G" break).

(f) Unusual attitudes.

(g) Specific flight characteristics.

(h) All systems operations associated with normal'in-flight functions.

(i) Abnormal and emergency procedures associated r(,ith cruise configuration.

(6) Descent.

(a) Normal descent.

(b) Abnormal and emergency procedures associated with descents.

(7) Approach and IandlPg.

(a) Maneuvering with all engines operative.

(b) Ianding gear, flap operation, speed brake, normal and abnormal extension.

(c) All engines approach and landing.

(d) Engine out approach and landing (in the case of three- and four-engine aircraft, one and two engines inoperative).

(e)' PAR approach and landing.

(f) IIS approaches and landings:

1 Normal.

2 Engine inoperative.

3 Category I.

4 Category II.

5 Category III (if applicable).

(g) Nonprecision approaches.

(h) Circling approach (if appropriate).

(i) No flap approach.

(j) Auto-coupler, auto-throttle, auto-land approaches.

(k) Manually controlled IIS with and without flight director.

(1) All engines operating missed approach.

(m) Engine out missed approach.

(n) Rejected hiding.

(o) Crosswind approach and landing.

(p) Navigation and communications.

(q) Abnormal and emergency procedures associated with approach and landing.

(8) Landing Roll and Taxi In.

(a) Spoiler operation.

(b) Reverse thrust operation.

(c) Directional control and ground handling.

(d) Normal brake and anti-skid operation.

(e) Alternate/emergency brake operation.

(9) Engine Shutdown and Parking.

(a) Systems operation.

(b) Parking brake operation.

(10) Motion System.

(a) The motion system meets the simulator requirements of Appendix 1 to this advisory circular.

(b) For Phase I, II, and III Simulators, special effects including:

1 Runway rumble, oleo deflections, reflecting effects of groundspeed and uneven runway characteristics.

2 Buffets on the ground due to spoiler/speedbrbak extension and thrust reversal.

3 Humps after lift-off of nose and main gear.

4 Buffet during extension and retraction of landing gear.

5 Buffet in the air due to flap and spoiler/speedbreak extension.

6 Approach-to-stall buffet.

7 Touchdown cues for main and nose gear.

8 Nosewheel scuffing.

9 Thrust effect kth brakes set.

(11) Visual - stem. The visual system meets the visual requirements of Appendix 1 to this advisory circular.

APPENDIX 3. SIMULATOR PEMRMANCE TESTS

a. Discussion. Simulator performance and system operation should be objectively ev ua ed by comparing each performance test conducted in the simulator to aircraft. performance. The performance of nonvisual and visual simulators should be compared to the best aircraft performance data available for each test. Phase I, II, and III simulators should be compared to actual flight test data. This will be accomplished by duplicating each actual flight test condition and response as accurately as possible in the simulator. To facilitate the comparison of performance between the simulator and the aircraft, a multichannel recorder or line printer should be used to record each performance test in the device. The multichannel recorder or line printer is required for Phase I, II, and III simulator evaluations and is desirable for nonvisual and visual simulator evaluations. The results of the multichannel recorder or line printer printouts should be cross-plotted onto the aircraft data to confirm simulator performance. The ATG provided by the operator should describe clearly. and distinctly how the device will be set up and flown to accurately duplicate the flight test data. Use of a driver program designed to automatically duplicate the flight test with accuracy and dependability is encouraged, but procedures should be included to positively determine that the driver is not doing anything more than accurately flying the simulator. All test results should, therefore, reflect the real time output to the flight crew so that the device would be in trim and would continue to fly if the driver was disengaged. This appendix contains the tests and tolerances which should be included in the operator's ATG. The tests include a column which shows the different flight regimes for each test where flight test data are desirable. While flight test data in each of these regimes are not a requirement for aircraft certificated prior to June 1, 1980, operators should be encouraged to provide simulator tests based on flight tests in these flight regimes. It is also recommended that the flight test data be selected to represent aircraft *performance* at normal operating weights and centers of gravity. If this is not possible, a second test at the opposite extreme is desirable.

b. Simulator Performance Tests. The ground and flight tests which should be evaluated, as appropriate o e ype of aircraft, are listed below. Although tolerances may be specified for dynamic tests, other criteria such as the general trends of the flight variables concerned are of major consideration in the evaluation of dynamic tests. If simulation can be enhanced by adjusting the tolerances in this appendix for a specific aircraft type the operator may submit justification for review by the NSPM upon initial approval request. Dynamic checks are recommended but not required for nonvisual and visual simulators.

c. Table of Performance Tests. An asterisk (*) before a test or immediately following a portion o a es n cates,that the test or portion of the test is not required for simulators oth r than Part 121, Appendix H simulators. In the Table of Performance Tests the blight Test Data Regime Codes are as follows:

0. Not Required
1. Ground/Takeoff
2. First Segment Climb
3. Second Segment Climb
4. Fnroute Climb
5. Cruise
6. Descent
7. Approach
8. Lending
9. No Flap Lending
10. Engine Out Lending
11. For these tests at least the following aircraft data should be available to compare with the time history from the simulator multi-channel r corder: pitch control f:rce, roll control force, rulder control force, pitch attitude, roll angle, yaw angle, airspeed, altitude and time.

NOTE: Flight test data are required by Appendix H to Part 121 in each of these regimes for aircraft issued an original type certificate after June 1, 1980. Operators are encouraged to present data in as many of these regimes as possible for aircraft previously certificated.

TEST	TOLERANCE	FLIGHT TEST DATA REUI
(1) CONTROL CHECKS.		
(a) Pitch Control Fbrce Calibration/Static/ Dynamic*	± 3 lbs	1,3,5,8
(b) Roll Control Fbrce Calibration/Static/ Dynamic*	+ 3 lbs	1
(c) Rudder Control Fbrce Calibration/Static/ Dynamic*	± 5 lbs	1
(d) Nosewheel Steering Force	+ 3 lbs	1
(e) Rudder Pedal Steering Calibration Fbrce	+ 3 lbs	1
(2) TAXI.		
*(a) Nosewheel Scuffing	-	0
*(b) Response to Nose-wheel Release from a Turn	-	1
*(c) Yd' nimum Radius Turn	+ 10 ft	1

TEST	TOLERANCE	FLIGHT TEST DATA REGIME
*(d) Rate of Turn Versus Nosewheel Steering Angle	-	1
*(e) Speed Effect on Nose wheel Steering	-	1
(3). TAW'' .		
(a) Ground Acceleration Time and Distance	+ 596 time and distance	1
(b) Minimum Control Ground	+ 3 knots	1
(c) Minimum Rotate Speed	+ 3 knots	1
(d) Minimum Unstick Speed	± 3 knots	1
(e) Types of Takeoff Rewired		1-3, 11
(1) Normal	[+ 101f t or 1096 of altitude, whichever is greater]	
(2) Engine Out Takeoff		
(3) Crosswind Takeoff		
(4) CLIMB.		
(a) Normal Climb	+ 596 climb rate or 100 FPM which-ever is greater	2,4!5
(b) Engine Out Second Segment Climb	"	3
(c) Engine Out Approach Climb	"	7
(d) Engine Out Landing Climb	"	8
(5) LONGITUDINAL CONTROL.		
(a) Power Change Dynamics	Pitch, angle of attack, rate of climb, and air-speed variations from trim versus time + 20,E	8
(b) Flap Change Dynamics		8

TEST	T07EtANCE	FLIGHT TEST DATA REGIME
(c) Gear and Flap Change Forces	+ 3 lbs or 1096	1,7
(d) Gear and Flap Operating Times	+ 3 sec	1,7
(e) Longitudinal Trim Changes	+.05 EPR, 1 unit4 Trim, 1' pitch	3,7,8
(f) Longitudinal Maneuvering Stability	+ 1096 of period and Time to half amplitude	3,5,7,8
*(g) Short Period Dynamics	"	3,7,8
*(h) Phugoid Dynamics	"	3,7,8
(6) LATERAL CONTROL.		
(a) Minimum Control Ai r	+ 5 knots	8
(b) Roll Response	+ 1096 or 2'	3,5,7,8,9
(c) Roll Overshoot	+ 1'	3,7,8
(d) Spiral Stability	±596 time to half amplitude	3,7,8
(e) Engine Out Trim	+1' bank	3,7
(f) Rudder Response	+ 1096 or 2'	3,5,7,8,9,10
(g) Cross Control	+2* wheel –1' bank/slip	3,7,8
(h) Dutch Roll Dynamics	+ 1096 of period, and time to half amplitude	3,5,7,8
(i) Stick Shaker, Airframe Buffet, Stall Speeds	± 3 knots	3,4,7,8
(7) LANDING.	[+ 3 lbs force + 10 ft or 1096 of altitude whichever is greater]	8,11
(a) Normal Landing		
(b) Hands Off Lending		

TEST	TOLII3ANCE	FLIGHT TEST DATA RDGIME
(c) Crosswind lending		
(d) Engine Out lending		
(d) Stopping Time	±596 time and distance or 200 ft, whichever is greater	8
(e) Stopping Time and Distance Reverse Thrust	"	8

MOTION SYSTIIK CHIM .

(a) Frequency Response Check.

(b) Leg Balance Check.

(c) Turn Around Check.

VISUAL SYS═ .

(a) With the final picture resolution, the distances at which runway features are visible should not be less than those listed below. Distances are equivalent distances measured from runway threshold to an aircraft aligned with the runway on an extended 3' glide slope.

1 Recognize runway and taxiways - minimum of 5 miles.

2 Longitudinal separation of striped block on runway minima. of 2 miles for daylightscenes and within the range of the landing lidits for night scenes.

3 Complete rurnW detail - minimum of 1/2 mile for daylight scene.

4 Strobe, approach, and runwy edge white lights - minimum of 5 miles.

5 Centerline lights - minimum of 3 miles.

6 Threshold lights (red and green) - minimum of 2 miles.

7 Touchdown zone lights - minimum of 2 miles.

8 VASI lights - minimum of 5 miles.

(b) For Phase I and visual simulators, visual system response from steady state in pitch, roll, and yaw should be a maximum of 366, milliseconds more than the time the aircraft would respond to a similar control input.

(c) For Phase II and III simulators, visual systein response described in Appendix 1, paragraph f.11.

APPENDIX 4. APPROVED TEST GUIDE SAMPLE FORMAT

DATE: REVISION NO: TEST NO: PAGE NO:

TEST: LATERAL CONTROL: ROIZ RESPONSE

TEST OBJECTIVE: Demonstrate that the simulation of lateral controls produces the correct ro responses, as compared to the aircraft.

TEST CONDITIONS: (These should be identical to the flight test conditions.)

Gross Weight	452,500 The
Center of Gravity	
Stabilizer Trim	e r
Thrust or EPR	4 Total
Indicated Airspeed	
Gear Position	___ Down
Flap Position	
Altitude	400 ee
Temperature	Standard
Yw Damper	n

TEST PROCEDURE: (This procedure should result in duplicating the flight test data in the simulator.)

1. Select "lateral" on the force box. Zero the indicators.
2. Freeze altitude, weight, end center of gravity.
3. Carefully trim the simulator to the test conditions. (EPR is approximately 1.20, pitch 3.50 and stabilizer trim 5.5 units.)
4. Select the desired test number on the recorder and turn the recorder on.
5. Establish a stable 330 right bank.
6. Apply 350 left aileron wheel rotation in 1.5 seconds. Use force box to determine wheel angle. Increase the wheel angle to 380 for remainder of test. Time from 300 to 300.
7. Terminate test at 400 left bank angle.

Time 30'0 to 300 Aircraft 7.0 sec Simulator 6.9 sec FAA 6.8 sec

RECORDING PROCEDURE: (This should result in recording simulator output coincident with flight test data needed to meet the test objective.)

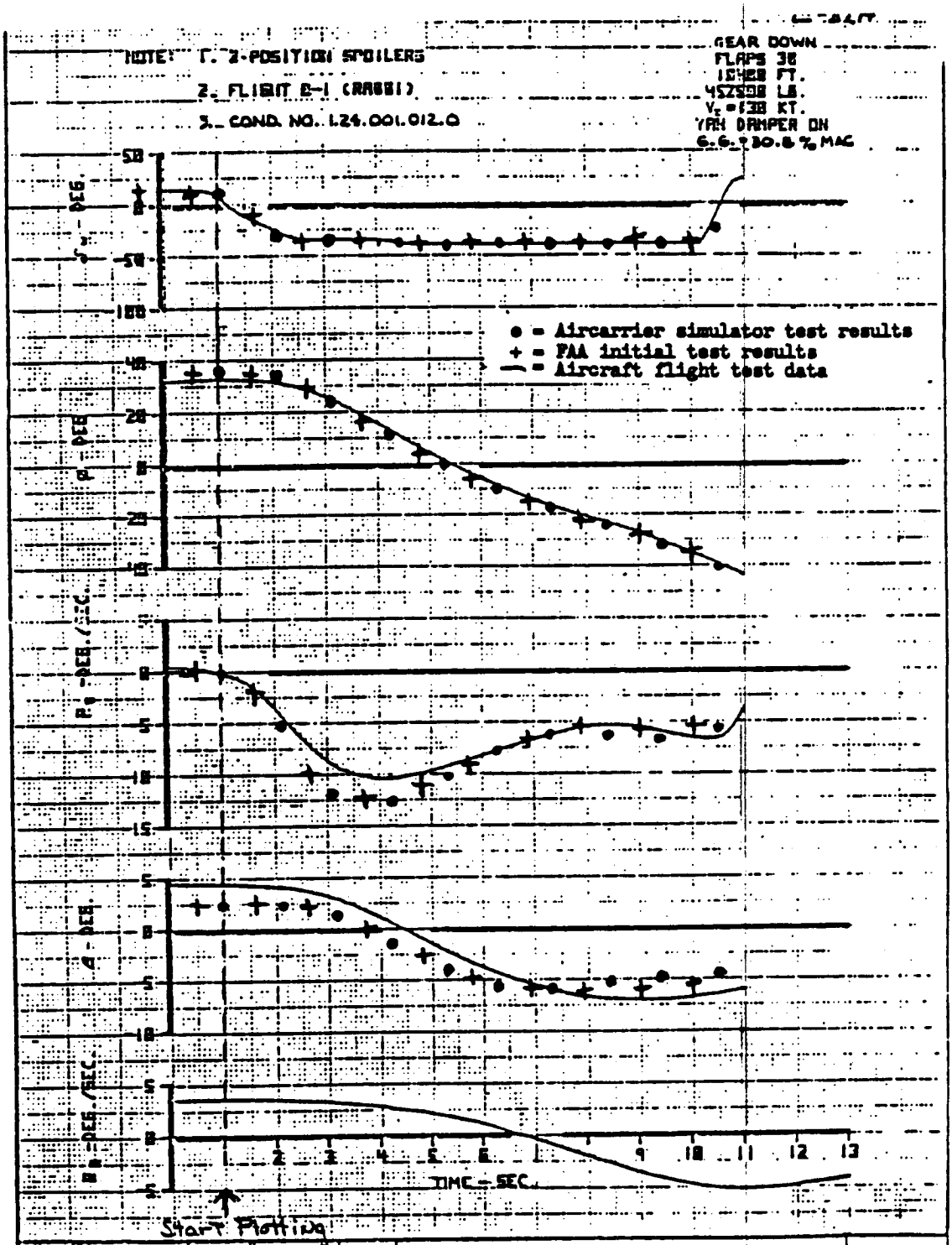
Make a multichannel time history recording of this test. Recorded parameters:

Channel 1 = Time; 2 = Bank Angle; 3 = Bank Rate; 4 = Sideslip Angle; 5 = Yaw Rate

Compare the results with the Boeing graph.

TOLERANCE: (From Appendix 3 of this Advisory Circular)

Bank angle + 1096 or 2 within lot 3 seconds.



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