UNITED STATES OF AMERICA
FEDERAL AVIATION AGENCY
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Civil Air Regulations Amendment 40-39
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PART 40—SCHEDULED INTERSTATE AIR CARRIER CERTIFICATION AND OPERATION RULES

Minimum Standards for Approval of Airplane Simulators

This amendment to Part 40 sets forth the standards which must be met for approval of airplane simulators to be used in training programs which are substituted alternately for pilot proficiency checks.

The Federal Aviation Agency published as a notice of proposed rule making (26 F.R. 8461) and circulated as Civil Air Regulations Draft Release No. 61-17 on August 31, 1961, a proposal to amend Parts 40, 41, and 42 of the Civil Air Regulations to prescribe standards for the approval of aircraft simulators, for training courses in aircraft simulators, and for the use of synthetic trainers for proficiency flight check maneuvers.

In addition to the proposals contained in Draft Release 61-17, the Agency published on March 10, 1962, a separate notice of proposed rule making (27 F.R. 2319), circulated as Civil Air Regulations Draft Release No. 62-9, which concerns the proposed overall training standards to be used in approving an air carrier's training program. Therefore, all comments received in response to Draft Release 61-17 which concern training programs and standards will be considered in conjunction with the comments received on Draft Release 62-9. All other comments received which concern the minimum standards for the approval of airplane simulators have been considered in connection with this amendment.

Some of the comments received in response to Draft Release 61-17 indicated a basic assumption with respect to simulators which is not essentially correct. It was contended that simulator requirements should not be specified except in those areas directly related to maneuvers which the pilot is required to perform, in an airplane, during the course of a proficiency flight check. This reasoning assumes that the simulator is only used as a substitute for an airplane in the conduct of proficiency flight checks. When the regulations were amended to allow substitution of an airplane simulator training course for each alternative proficiency flight check in an airplane, the added contribution to safety which is derived from the full simulator training courses was considered as a justification for the amendment. Accordingly, if the simulator is to be used it should perform to the degree required to accomplish such a training course. Thus, the standards and tolerances contained in this amendment as Appendix C to Part 40 are those which must be met prior to approval of an airplane simulator for use in a simulator training course which is to be used as a substitute for alternative pilot proficiency flight checks as provided by §§ 40.302(b)(3) and 40.305(b). To make this clear, the term "airplane simulator which meets the standards set forth in Appendix C" has been substituted in § 40.302(b)(3) of this amendment for the words "aircraft simulator," and the requirements in present § 40.302(b)(3) for approval of an airplane simulator have been incorporated in the Appendix.

In consideration of the many comments received in response to Draft Release 61-17, the standards contained in Appendix C for approval of the simulator differ somewhat from those proposed in the draft release. For example, the phraseology "* * * minimum and maximum limits of the systems * * * as shown in the approved Airplane Flight Manual and/or the maintenance section of the air carrier's manual" contained in section 1(a) of the proposal is being deleted for clarity. Industry objection to this terminology was based on the misunderstanding that it was applicable to flight characteristics, when in fact it applies only to airplane systems. To clarify this requirement this section has been changed by specifying the items of the systems which the simulator is required to simulate for approval.

The proposed section 1(c)(1) has been renumbered as section 1(b)(1) and revised to permit any adequate airplane data obtained from sources other than the approved Airplane Flight Manual, Type Inspection Report, or other flight test data provided by the airplane manufacturers, to be used for comparison purposes. As a determination by the Agency of the adequacy of such data cannot always be made immediately, this amendment requires the submission of these data by the carrier sufficiently in advance of the date set for the simulator evaluation to permit the Agency to investigate their adequacy.

Section 1(b)(2) provides for the acquisition of airplane data by flight tests conducted in the air carrier's airplane. This section clearly indicates that the procedures and methods to be followed in obtaining data must be coordinated with the FAA representative participating in the flight test program conducted to obtain these data. As such coordination, when accomplished, would require the concurrence of the participating FAA representative with the flight test methods and procedures to be utilized to obtain the data, the proposed reference to Part 4b of the Civil Air Regulations with respect to such flight tests is unnecessary and is deleted in this amendment. This section has also been changed to expressly provide that an Agency representative may permit the carrier to conduct such portions of the flight test program as he deems appropriate without participation by the representative.

The air carriers objected to the proposed requirements for airplane simulator maintenance. These objections indicated a need for rephrasing the requirements as proposed, without substantive change, to reflect more clearly the intent of the requirements. As a result, they have been rewritten and placed in § 40.302(b)(3). As rewritten, the requirements provide:

(1) That the air carrier is responsible for maintaining the simulator to the same standards as required for initial approval;

(2) That simulator flight training and/or proficiency flight check activities must not be started with a "cold" simulator; however, in order not to hinder the carrier's flexibility in scheduling the use of a simulator, the functional preflight check of the simulator is required to be conducted only once each day that the simulator is to be used for training or the conduct of proficiency flight checks, and at any convenient time prior to commencing daily simulator operations;

(3) That a daily discrepancy log must be maintained;

(4) That the simulator be modified, if appropriate, when a modification is made to the airplane; and

(5) That procedures for the continued use of the simulator with certain inoperative instruments or equipment may be established.

The Air Transport Association objected to proposed paragraph (x) of section 3 on the ground that it would "give blanket authority to the FAA to require additional systems" not specifically required by regulations. As it is intended that all standards for the approval of airplane simulators will be promulgated with opportunity for the industry to participate in the rule making, paragraph (x) has been deleted.

In order to indicate more specifically the tolerances applicable in each area of performance, the format of section 4(a) has also been revised.

With respect to rate-of-climb tolerances, Appendix C, while specifying a tolerance of ±50 feet per minute or 10 percent for propeller airplane simulators, allows ±100 feet per minute or 10 percent for jet airplane simulators in view of the much higher rates of climb encountered in the operation of jet airplanes.

A new item, section 4(a)(6), "Minimum control speed," has been inserted. As pointed out by industry comment, no airspeed tolerances had been proposed for V_{MC}.

Considerable objection was raised by the air carriers to the proposed requirement pertaining to stall speeds. As a result of consideration of comments received, these standards provide more flexibility with respect to the range between initial buffet and stall, and give recognition to the relatively greater importance of accurate simulation of stall warning (initial buffet). These standards also clarify the stall requirements by specifically listing the applicable configurations in which stall and stall warning speeds must be checked.

With respect to the standards applicable to simulator flight characteristics, as proposed in section 4(b), several changes have been made as a result of industry comment. These do not constitute substantive changes in the intent of the proposed standards but do more clearly state the applicable requirements. These changes are as follows:

(1) In lieu of the proposed reference to force reversal, these standards require that, with respect to static longitudinal stability, the slope of the stick force curve of the simulator shall be positive.

(2) The standards have been rewritten to preclude any interpretation which would permit an individual inspector to prescribe specific standards other than those contained in Appendix C. As the prescription of specific limitations in certain areas is not feasible, the FAA personnel who evaluate an airplane simulator will adjudge the adequacy of simulation in these areas.

(3) The requirement contained in the proposed section 4(b)(1) that the simulator return to trim speed within ±5 knots was unintentional. Comment received called attention to the fact that the airplane, during certification, is required to return to within 10 percent of trim speed. The standards contained in Appendix C require that the simulator return to trim within ±5 knots of the speed at which the airplane returned during certification tests.

(4) The proposed sections 4(b)(3) and 4(b)(4) are being deleted as redundant in view of the fact that it is intended only to measure these forces in determining adequate simulation of minimum control speed as required in the proposed section 4(b)(5).

(5) Appendix C permits the authorized representative of the Administrator, in the event data pertaining to stick force versus "g", rudder and aileron forces at V_{MC}, or roll rates are not available in the Type Inspection Report, to use judgment in determining the adequacy of simulation in these areas.

(6) The proposed section 4(b)(11) has been deleted as the standards contained herein are complete. Should additional standards be considered necessary in the future, they will be included in Appendix C only after due notice of proposed rule making and a thorough consideration of industry views thereon.

The air carriers objected to the requirements proposed in section 5 regarding the standards of tolerance for simulator navigational recorders on the basis that the recorder should be treated as nonrequired auxiliary equipment. There is merit to their contention that a check pilot can judge a pilot's performance without reference to the recorder. However, in order for a simulator to fulfill completely its training objectives, it must, in addition to being able to simulate indications of position with respect to radio navigational facilities, provide a record of the track and altitude flown. In order to do so realistically, its track, distance traveled, and, in the case of an ILS approach, its descent path in still air, must correspond with heading, true airspeed, and, during ILS approaches, glide path, altitude, airspeed, and rate-of-descent indications. In addition, the path of flight must be recorded in such a manner as to be available to the trainee and to the instructor or check pilot for evaluation after completion of a flight. As the recorder unit, of which the recorder indicators are in integral part, is essential to the navigational ability of most simulators presently in general use, the proposal specified simulator navigational accuracy in terms of recorder accuracy. In order to indicate more clearly the intent of these standards with respect to simulator navigational ability, they have been rewritten to specify tolerances pertaining to the navigational accuracy of the simulator. With respect to the tolerances themselves, the tolerances for an ILS glide path have been liberalized in accordance with comment received.

Finally, section 6 of the proposal has been rewritten, in accordance with industry suggestions, to indicate more clearly that, while failure to maintain a simulator to prescribed standards and tolerances shall be cause for cancelling approval for its use in accordance with the provisions of § 40.302(b)(3) and § 40.305(b), training may be continued with certain instruments or equipment inoperative. Further, this provision has been placed in § 40.302(b)(3) instead of in the Appendix.

Interested persons have been afforded an opportunity to participate in the making of this regulation (26 F.R. 8461), and due consideration has been given to all relevant matter presented.

In consideration of the foregoing, Part 40 of the Civil Air Regulations (14 CFR Part 40, as amended), is hereby amended as follows, effective June 10, 1963:

1. By amending § 40.302(b)(3) to read as follows:

§ 40.302 Pilot checks.

* * * * *

(b) *Proficiency check.*

* * * * *

(3) Subsequent to the initial pilot proficiency check, an approved course of training conducted in an approved airplane simulator, if satisfactorily completed, may be substituted at alternate 6-month intervals for the proficiency checks required by subparagraph (1) of this paragraph if the simulator meets the minimum standards set forth in Appendix C and:

(i) The simulator is maintained at the same level as required for initial approval;

(ii) A functional preflight check of the simulator is performed each day prior to commencing simulator flight training or proficiency checks;

(iii) A daily discrepancy log is maintained and an entry of each discrepancy is made by the simulator instructor or check airman before termination of each training or check flight; and

(iv) If a modification is made to the airplane, a corresponding modification is made to the simulator if necessary for flight crew training or proficiency checks.

The simulator may be used with inoperative instruments or equipment, if they are not applicable to the particular phase of training being given.

2. By deleting § 40.302–5.

3. By adding a new Appendix C, "Minimum Standards for the Approval of Airplane Simulators," to read as hereinafter set forth.

(Secs. 313(a), 601, 604, 605; 72 Stat. 752, 775, 778; 49 U.S.C. 1354, 1421, 1424, 1425)

Issued in Washington, D.C., on April 4, 1963.

N. E. HALABY,
Administrator.

APPENDIX C

MINIMUM STANDARDS FOR THE APPROVAL OF AIRPLANE SIMULATORS

1. *Application for approval.* An application for approval of an airplane simulator is submitted, in triplicate, to the authorized representative of the Administrator. The application must include the following:

(a) Information sufficient to show that the simulator adequately simulates the type of airplane with respect to the items and systems listed in section 3 of this appendix.

(b) Comparative data sheets showing that the performance and flight characteristics of the airplane simulator have been flight checked and found to be within the limits prescribed for the items listed in section 4 of this appendix. The airplane data used for comparison purposes must be applicable to the currently certificated airplanes. Such data may be obtained:

(1) From the approved Airplane Flight Manual, Type Inspection Reports, or other flight test data provided by the airplane manufacturer. Other sources of airplane data may be used if approved by the authorized representative of the Administrator. Such data must be submitted so as to allow sufficient time for investigation of their adequacy.

(2) By flight tests conducted in the air carrier's own airplane. If this procedure is used, performance and flight characteristics data for the center of gravity limits and weights used during training will be satisfactory. Before starting these flights, an outline of the tests to be conducted in the airplane must be prepared and coordinated by the air carrier with the authorized representative of the Administrator. This outline must contain procedures to be followed and data to be obtained during each phase of the flight testing program. The authorized representative of the Administrator may observe and participate in the flight test program to the extent he considers necessary and appropriate. Any data so obtained will be acceptable for use by other air carriers using the same type of airplane if appropriate arrangements are made with the air carrier originating the data.

2. *General requirements.* (a) The effect of changes on the basic forces and moments

must be introduced for all combinations of drag and thrust normally encountered in flight. The effect of changes in airplane attitude, power, drag, altitude, temperature, gross weight, center of gravity location, and configuration must be included.

(b) In response to control movement by a flight crew member, all instrument indications involved in the simulation of the applicable airplane must be entirely automatic in character unless otherwise specified.

(c) The rate of change of simulator instrument readings and of control forces must, unless specific tolerances are otherwise specified in this Appendix, reasonably correspond to the rate of change which would occur on the applicable airplane under actual flight conditions, for any given change in the applied load on the controls, in the applied power or in aircraft configuration.

(d) Control forces and degree of actuating control travel must, unless specific tolerances are otherwise specified in this Appendix, reasonably correspond to that which would occur in the airplane under actual flight conditions.

(e) Through the medium of instrument indication, it must be possible to use the simulator for the training and checking of a pilot in the operational use of controls and instruments on the applicable airplane model during the simulated execution of ground operation, takeoff, landing, normal flight, unusual attitudes, navigation problems and instrument approach procedures. In addition, the simulator must be designed so that malfunction of aircraft engines, propellers, and primary systems may be presented and corrective action taken by the crew to cope with such emergencies.

(f) Suitable course and altitude recorders must be provided.

(g) Communication and navigation aids of the applicable airplane must be simulated for on-the-ground and in-flight operations.

3. *Minimum standards for simulation of airplane systems.* The simulator shall simulate at least the following items and systems which are appropriate to the airplane being simulated:

(a) All normal cockpit noise related to engine or aerodynamic noise (adjustable volume is permissible);

(b) All flight controls;

(c) Gust locks;

(d) Trim tabs;

(e) Landing gear operation;

(f) Wheel brakes;

(g) Steering mechanisms used on the ground;

(h) Wing flaps and spoilers;

(i) Powerplant operations;

(j) Propeller controls and circuitry;

(k) Antidetonation injection systems;

(l) Fuel and oil systems;

(m) Cockpit—the simulator shall represent a full scale mockup, including normal flight crew stations and accommodations for the instructor or check airman, and shall be representative of a typical fleet airplane;

(n) Circuit breaker stations manageable by the flight crew in the flight compartment (those not related to essential flight equipment or systems need not be operative);

(o) Hydraulic systems;

(p) Fire detection and extinguishing systems;

(q) Pneumatic systems (including emergency airbrakes);

(r) Electrical systems;

(s) Interior cockpit lights;

(t) Exterior light controls;

(u) Pressurization and air-conditioning systems (instrument indication and warning signals);

(v) De-icing and anti-icing systems;

(w) Supplemental breathing systems (the systems may be charged with or vented to air); and,

4. *Minimum standards of tolerance for performance and flight characteristics.* The simulator shall simulate the performance and flight characteristics of the particular type of airplane being simulated within the tolerance limits specified in paragraphs (a) and (b) of this section. If alternate tolerance limits are given, whichever is the greater shall apply.

(a) *Performance characteristics.* (Airplane weight and center of gravity optional.)

(1) Propeller feathering time, ±3 seconds.

(2) Landing gear operating time, ±3 seconds.

(3) Wing flap operating time, ±3 seconds.

(4) Takeoff acceleration time, ±10 percent.

(5) Calibration of gyrocompass and turn-and-bank indicator in standard rate turns and 30-degree banked turns, through a range of 180 degrees. Average rate of turn shall be within ±10 percent.

(6) Minimum control speed (in flight), ±5 knots.

(7) Stall speeds and stall warning speeds (wings level), as follows:

(i) Stall warning speed (initial buffet) in the takeoff, approach, and landing configuration, ±3 knots.

(ii) Stall speeds in the takeoff, approach, and landing configuration, ±5 knots.

(iii) The difference between stall warning (initial buffet) and stall speed shall be within ±5 knots of that for the appropriate airplane, but in no case should the stall occur before the stall warning.

(8) Engine power (thrust) calibration at takeoff and maximum continuous ratings over an altitude range, as follows:

(i) Reciprocating engines: MP, for a given BMEP and RPM, ±1 inch.

(ii) Turbine engines: N_1 and N_2, for a given EPR, ±2 percent.

(iii) Critical altitude, piston engine simulators only, ±800 feet or ±10 percent.

(9) Speed versus power in level flight at cruise altitude, ±5 knots, or 3 percent, or 0.03 Mach.

(10) Rates of climb versus altitude in the following configurations (propeller airplane simulators, ±50 feet or 10 percent; jet airplane simulators, ±100 feet or 10 percent):

(i) Takeoff gear down (one engine inoperative),

(ii) Takeoff gear up (one engine inoperative),

(iii) Final takeoff (one engine inoperative),

(iv) All engines en route,

(v) One-engine-inoperative en route climb,

(vi) Two-engine-inoperative en route climb (for airplanes with four or more engines),

(vii) Approach (one engine inoperative), and

(viii) Landing.

NOTE: At least two airplane weights must be included in at least one configuration, and at least two outside air temperatures must be included in at least one other configuration.

(11) Rates of climb versus airspeed for one takeoff, and one en route configuration (propeller airplane simulators ±50 feet or ±10 percent; jet airplane simulators ±100 feet or ±10 percent).

(12) In determining compliance with subparagraphs (9), (10), and (11) of this paragraph, MP/BMEP/RPM relationships shall conform to airplane data within the tolerance specified in subparagraph (8)(i), and EPR/Compressor RPM relationships shall conform to airplane data within the tolerance specified in subparagraph (8)(ii) of this paragraph.

(b) *Flight characteristics.* (Airplane weight and center of gravity optional.)

(1) Static longitudinal control stability: In the landing, approach, cruise (high and low altitude), and climb configurations, return to trim, when the simulator speed is caused to depart 15 percent from trim speed, shall be within ±5 knots of approved airplane data. The slope of the stick force curve shall be positive. One of these configurations shall cover a center of gravity range.

(2) Control forces: Simulator control forces in the following areas shall be within ±8 pounds or ±25 percent of the forces encountered in the airplane as indicated by the required data; except that, in regard to rudder forces, the tolerance shall be ±10 pounds or ±20 percent:

(i) Longitudinal control forces during flap retraction (power off and power on), flap extension, power or thrust application, go-around following a balked landing.

(ii) Minimum control speed (in flight), rudder and aileron forces.

(iii) Stick force per "g."

(3) The roll rate of the simulator shall be within ±2 seconds or ±25 percent, whichever is greater, of that of the airplane.

NOTE: If data for items in subparagraphs (2)(ii), (2)(iii) and (3) of this paragraph are not contained in the Type Inspection Report, the authorized representative of the Administrator may adjudge the adequacy of simulation.

(4) In the following areas, specified tolerance limitations are not set forth in these standards. In these areas of flight characteristics, when appropriate to the type of airplane being simulated, the adequacy of simulation shall be subject to the approval of the authorized representative of the Administrator:

(i) Compressibility trim change.

(ii) Approaches to stall in the takeoff, approach, and landing configuration (wings level), from initial buffet to stall; except that at least one approach to a stall must be done in a 20-degree bank turn.

(iii) Buffet at high Mach numbers up to design Mach limits.

(iv) Dutch roll.

(v) Emergency descents.

5. *Minimum standards of tolerance for simulator navigational accuracy.* At any altitude, on any heading, and at any airspeed, the navigational accuracy of the simulator must be as follows:

(a) The distance traveled with zero wind in a particular time interval must be equivalent to ±5 percent of the horizontal component of the true airspeed multiplied by the time interval.

(b) The track of the simulator with no wind must agree with the true heading of the simulator within ±3 degrees which shall include allowances for instrument error. (This shall apply when the simulator is turning as well as flying a straight course.)

(c) During simulated ILS approaches with zero wind, the descent path of the simulator, as indicated by airspeed, altitude, and rate of descent, must agree with the descent path as indicated by the flight instrument indicating glide path deviation, within ±20 feet from 0 to 200 feet, ±10 percent of the height above the runway, from 200 to 1,000 feet, and ±100 feet from 1,000 to 5,000 feet above the airport elevation.

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