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Part V

# Department of Transportation

## Federal Aviation Administration

## Advanced Simulation

**DEPARTMENT OF TRANSPORTATION**

**Federal Aviation Administration**

**14 CFR Parts 61 and 121**

**[Docket No. 19758; Amdts. Nos. 61-69 and 121-161]** See correction

**Advanced Simulation**

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Final rule.

**SUMMARY:** This rule: (1) Allows expanded training, checking, and certification of flight crewmembers in advanced flight training simulators; and (2) Encourages operators to upgrade their simulators and to perform a higher percentage of training in simulators so that the total scope of flightcrew training is enhanced. The benefits of this rule include substantially improved safety, fuel conservation, and a reduction of airport congestion. In addition, this rule offers a regulatory alternative which could result in significant cost savings for air carriers and represents a significant step in President Carter's program to reduce regulatory burdens through development of alternatives.

**EFFECTIVE DATE:** July 30, 1980.

**FOR FURTHER INFORMATION CONTACT:** H. E. Smith, Regulatory Projects Branch (AVS-24), Safety Regulations Staff, Associate Administrator for Aviation Standards, Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, D.C. 20591; telephone (202) 755-8716.

**SUPPLEMENTARY INFORMATION:**

**History**

This final rule is based on Notice of Proposed Rule Making (NPRM) No. 79-18, published in the **Federal Register** on November 13, 1979 (44 FR 65550). All interested persons have been given an opportunity to participate in the making of the rule, and due consideration has been given to all matter presented.

**Background**

As the state-of-the-art in simulator technology has advanced, more effective use has been made of the airplane simulator in training, checking and certification of flight crewmembers. Simulators can provide more indepth training than can be accomplished in the airplane with a very high percentage of transfer of learning from the simulator to the airplane. There are many advantages in the use of *good* simulators for training.

1. Who can be trained?
   a. Entire flightcrew.
   b. Individual flight crewmembers.
2. What training can be accomplished?
   a. Normal operations procedures.
   b. Abnormal operations procedures.
   c. Emergency procedures.
   d. Any weather condition.
   e. Any lighting condition.
   f. Any airport location.
   g. Training situations which would be impossible or unsafe to conduct in the aircraft, such as wind shear or blown tire on landing.
3. When can training occur?
   a. 24 hours a day.
   b. Any day of the year.
4. Where can the training take place?
   a. Any building that can house the simulator.
   b. Any place in the world.

All of this adds up to training flexibility with maximum safety. In addition, the use of simulators instead of the airplane results in great cost reductions for the operator and achieves the benefit of fuel conservation and a decrease in airport noise.

During the last 25 years, as simulator technology has improved, changes to the Federal Aviation Regulations (FAR) were made to allow the increased use of simulators in air carrier training programs. FAA acknowledgment of the value of simulator training began in 1954 when air carriers were allowed to perform all but four proficiency check maneuvers in a simulator. From this beginning, the FAA has continued to promote, evaluate, and regulate the use of simulation in aviation. In the late 1960's visual attachments appeared on the market. Since that time, a breakthrough in computer technology has permitted the development of computer-generated image (CGI) visual systems. In December 1973, FAR Amendments 61-62 and 121-108 were issued which allowed additional training in visual simulators. Because many training maneuvers, such as engine failure on takeoff and visual approaches, require visual cues to provide the necessary training, these amendments resulted in reducing airplane flight training to approximately 1½ hours for an airline transport pilot certificate. Because of the limitations of simulators at that time, the 1½ hours of actual flight time was necessary to train the pilot to land the airplane, fly other maneuvers, and to become familiar with the feel of the airplane before the FAA certification check. A 1978 amendment to § 121.439 (Amendment 121-148) allowed a simulator approved for the landing maneuver to be substituted for the airplane in a pilot recency of experience qualification. The landing maneuver approval program associated with that rule change and its simulator approval criteria constituted a significant step toward the optimum utilization of airplane simulators in flight training and checking.

Based on the success of the landing maneuver approval program, FAA-industry operational studies, and a review of the latest simulator technology, the FAA proposed its advanced simulation plan in Notice 79-18 to outline the steps for optimum utilization of airplane simulators.

Notice 78-18 proposed to amend §§ 61.157 and 121.407 to allow expanded training, checking, and certification of flight crewmembers in an advanced flight training simulator if that simulator—

(1) Is approved under § 121.407 of Part 121 and meets the appropriate simulator requirements of Appendix H to Part 121; and

(2) Is used as part of an approved program that meets the training requirements of § 121.424(a) and (c) and *Appendix H to Part 121.*

The notice further proposed a new Appendix H to Part 121. This Appendix provides criteria and a means for achieving approval of advanced airplane simulators for flightcrew training and checking. This plan for achieving the goal of advanced simulation consists of three major phases and an interim phase to facilitate the plan's implementation. The three-phase plan provides guidance through a progressive upgrade of flightcrew training simulators so that the total scope of flightcrew training can be enhanced. Each phase encompasses the preceding phase so that the final advanced simulation phase includes all the requirements of preceding phases. Appendix H describes the simulator and visual system requirements which must be achieved to obtain approval of certain types of training in the simulator. The requirements in the Appendix are in addition to the simulator approval requirements in § 121.407.

**Phase I**

Phase I is the current landing approval program. The training permitted under this phase is currently authorized for fully qualified air carrier pilots by § 121.439 and through FAA exemptions. Phase I is designed to encourage operators to upgrade their older simulators to the greatest extent possible.

**Phase II**

Phase II is designed to provide new simulator training capabilities by expanding the ability of the simulator to portray the ground and flight

environment and increasing the simulator's responsiveness. In addition to upgrading the simulator, a special 4-hour Line Oriented Flight Training (LOFT) course is required after the appropriate Part 61 or 121 simulator check. This course must be approved by the Administrator and be designed to prepare the flight crewmember for line operations. Under Phase II, transition and upgrade training and checking are accomplished in a simulator. Transition training is the training required for a pilot to move from one airplane to another in the same airplane group, for example, copilot B-727 to copilot B-707. Upgrade training, as it is applied in this rule, is upgrading from copilot to captain. At the completion of a Part 61, Appendix A, check in the simulator, an appropriate airman certificate or an airplane rating, or both, will be issued. Instructors used in these Phase II training programs, as well as pilots who participate, must be highly experienced. The pilots must be qualified at least as second in command in an airplane in the same group and must meet the requirements of Appendix H before being eligible for Phase II certification.

**Phase IIA**

Under Phase IIA, any Part 121 operator may conduct Phase II training for 3½ years in a simulator approved for the landing maneuver under Phase I, if the operator meets the additional requirements in Appendix H and submits a plan for approval by the Administrator to upgrade its simulator(s) to meet the Phase II standards. This interim program is designed to provide time and economic benefit to an operator to upgrade its simulators while ensuring safety through additional training requirements. Through the upgrading of industry simulators, further training in adverse conditions experienced in the operations will be possible.

Each Part 121 operator who submits an acceptable simulator upgrade plan to the Administrator before July 30, 1981 may apply for approval to use a Phase I simulator for transition and upgrade training as described in Phase II of the plan. When Phase II simulator requirements are met, the additional training requirements specified in Phase IIA, except the 4 hours of LOFT training discussed above, are removed. Other Part 121 training and operating experience requirements still apply.

Phase IIA interim approval ends for each Phase I simulator listed in the operator's approved plan 3½ years after it is approved for Phase IIA training. Approval of the plan will be withdrawn if any simulator is not upgraded according to the operator's approved simulator upgrade plan. This would result in loss of all Phase IIA training. Extension of Phase IIA training will not be considered because the comprehensive goal of the plan for simulator upgrade would be moribund if the plan were not implemented as developed and approved.

**Phase III**

Phase III is designed to allow all but static airplane training, the line check, and operational line experience to be conducted in an advanced airplane simulator. At the completion of the final simulator check, the applicant will receive the appropriate certificate or rating. Due to the scope of the training and the possible low experience level of the training candidates, a high degree of simulator fidelity and realism is mandatory. (Applicants must still meet the requirements for an airline transport pilot certificate, including 1500 hours of pilot flight time, to be eligible for that certificate under this plan.) This phase is also designed to guide research in simulator technology to meet training needs determined from airplane accident investigations. The visual requirements of Phase II must also be represented in daylight, dusk, and night scenes under Phase III. Therefore, night and dusk scenes may not be degraded under Phase III.

The advanced simulation plan outlined in Appendix H applies only to an operator who uses the simulator under an approved Part 121 training program. To conduct total initial, transition, upgrade, or recurrent training in a simulator under the plan, all required simulator instruction and checks must be conducted in a simulator as part of an approved advanced simulation training program. The training program would integrate Phase II and III simulators with other simulators and training devices to maximize the total training, checking, and certification functions. Certificates issued during Phase IIA will contain a limitation which requires the pilots to operate under Part 121 until they have met the line operating experience requirements of Appendix H.

**Discussion of Benefits**

*Safety.* In the past few years significant developments in simulator technology have made it possible to realistically simulate a specific airplane and its ground and flight environment. By taking advantage of the developments in the state-of-the-art of airplane simulators, flightcrew training could be upgraded from a strictly maneuver and procedures-oriented program to a program where crewmembers can also gain experience in dealing with abnormal flight, system, and environmental situations. This can be illustrated by comparing current flightcrew simulator training with improved training now possible in advanced simulators. Current flightcrew training is based on the maneuvers which have been historically conducted in the airplane. These maneuvers include stalls, steep turns, instrument approaches and airplane engine and system failures. Since current training is based on that which can be accomplished in an airplane, the training is procedurally oriented and designed to avoid placing the airplane in an unafe condition. Simulators have been able to provide maneuvers training including airplane engine and system failures training so that, for example, training in a critical-field-length engine failure on takeoff maneuver can be conducted safely and realistically. However, because simulators have been designed to provide only the types of maneuver training that have been historically conducted in the airplane, they have not been capable of providing training in different flight environments, such as near thunderstorms or on icy runways which might be encountered on line flights. This type of training can be conducted in advanced simulators.

A review of NTSB accident statistics shows that pilot error and adverse weather conditions are the primary causes of most air carrier accidents. This review indicates that it is not the pilot's inability to control the airplane or to fly a specific maneuver but rather the failure of the crew to deal with the abnormal flight situation which causes the accidents. Improved training including line oriented flight training in advanced simulators could be the most significant means for reducing these types of accidents.

Under the FAA's advanced simulation plan, which is implemented in this rule, simulators will have the capability to be programed to represent a full range of airplane flight conditions as well as specific airplane accidents in abnormal environmental conditions. In this way flightcrews could experience a far-ranging set of flight environments and malfunctions. This could assist the crew in making proper judgments when abnormal situations occur in flight. Safety would, therefore, be enhanced dramatically by producing better trained pilots. Without upgrading simulators, upgrading training to this extent will be impossible. Safety would also be greatly increased because advanced training simulators can provide training without

the risk of airplane training accidents. Since 1962 U.S. air carriers have experienced 67 training accidents of which 6 were fatal accidents. In the future, training accidents could be avoided through use of advanced simulation.

*Energy Savings.* According to information available to the FAA, an estimated 32,000,000 gallons of fuel could be saved each year if Part 121 air carriers use advanced flight training simulators instead of airplanes for transition and upgrade training under Phase II. Over 73,000,000 gallons could be saved each year if the advanced simulation plan were fully implemented (Phase III). These figures are based on 1979 training flight hours utilized by air carriers. Actual fuel savings will depend on the number of Part 121 operators who elect to upgrade their simulators.

*Economic Impacts.* As a result of the economic and energy benefits which will result from this rule, there is no economic burden imposed on the industry, the government, or the private sector by this action. This rule offers a regulatory alternative which will result in cost savings for any operator who elects to take advantage of it. Under the plan the operator can realize more savings for each Phase of the plan it implements. Economics do, however, play an important role in an operator's decision to upgrade its simulators according to the advanced simulation plan. Basically, the operator has an opportunity to balance the cost of upgrading its simulators, including the value of the safety and training benefits of using advanced simulators, against factors such as airplane operating costs, time out of revenue service, scheduling, and maintenance problems.

Costs involved in flying the airplane vary from operator to operator depending, for example, on the type of airplane involved, the number of crewmembers who require certain types of training, revenue lost, union contracts, and training base location. Costs for upgrading a simulator also vary depending on the airplane type and the condition of the simulator before upgrade. As can be seen in the following chart, the FAA estimates that over $67 million per year could be saved by the U.S. air carriers in fuel costs and $25 million in operating costs if the industry fully implements the advanced simulation plan. In addition, economic benefits will result to the public and the operator by having additional airplanes available that would otherwise be committed to training.

**Savings Per Year**

| Trunks, airplane type | Volume of fuel/block hours (average) | Operating cost/block hours [1] (average) | Estimated crew training hours/year | Fuel in gallons | Fuel cost (×$.915/gal) [2] | Operating cost |
|---|---|---|---|---|---|---|
| B-727(3) | 1,263 | 336.28 | 15,400 | 19,450,200 | $17,796,933 | $5,176,172 |
| DC-10(3) | 2,257 | 796.44 | 3,300 | 7,448,100 | 6,815,100 | 2,628,252 |
| B-747 | 3,259 | 1,228.70 | 4,510 | 14,698,090 | 13,448,752 | 5,541,437 |
| L-1011 | 2,338 | 1,159.71 | 4,510 | 10,544,380 | 9,648,108 | 5,230,292 |
| B-707(4) | 1,817 | 495.89 | 3,245 | 5,896,165 | 5,394,991 | 1,609,163 |
| DC-8(3) | 1,742 | 568.34 | 3,850 | 6,706,700 | 6,136,631 | 2,188,109 |
| B-737-200 | 842 | 301.30 | 4,840 | 4,075,280 | 3,728,881 | 1,458,292 |
| DC-9(3) | 896 | 299.50 | 2,640 | 2,365,440 | 2,164,378 | 790,680 |
| A-300B | 1,808 | 542.74 | 1,320 | 2,386,560 | 2,183,702 | 716,417 |
| Total | | | 43,615 | 73,570,915 | 67,317,388 | 25,340,814 |
| Total industry operating and fuel cost savings (per year) | | | | | | 92,658,202 |

[1] Excluding crew and fuel.

[2] Based on March 1980 of $0.88 to 0.95/gal range average for domestic trunks. Predict $1.05/gal DOE quoting CAB data.

**Notes**

Columns 1 and 2 are weighted averages for the airplane types listed followed by a number in parenthesis. That number indicates how many series of that type airplane are reported in *Aircraft Operating Cost and Performance Report* published by the CAB in July 1979, covering calendar years 1977 and 1978. The operating data in column 1 and 2 are CY 1978 data.

Column 3 is the product of a sample of 15 out of 33 air carriers times the factor 2.2, which represents the ratio of the population to the sample.

*Environmental Impact.* While it is impossible to accurately determine the environmental impact of the advanced simulation plan due to its permissive nature, it is certain that all impacts would be beneficial. Air carriers estimate that over 39,000 hours of flight training time in large turbojet aircraft were logged during 1979. This training is almost always conducted at low altitudes near major metropolitan airports. To the extent that air carriers implement the advanced simulation plan, there will be a proportionate reduction in airplane operations and related environmental effects.

It is apparent from the discussion of the benefits of this rulemaking action that the FAA has developed a program which implements Executive Order 12044 and President Carter's policy of encouraging innovative solutions to regulatory needs.

**Discussion of Comments**

During the comment period and its extension, the FAA received 28 comments in response to Notice 79-18.[1] These comments represented the views of individuals, airline organizations, labor organizaitons, simulator manufacturers, and other government agencies. Twenty-four commenters highly favored the proposal and four opposed it. Several commenters recommended changes to improve certain technical portions of Appendix H. These suggestions have been implemented in many cases. A discussion of each of the significant points raised by the commenters follows:

1. *Comment*—Too specific. By defining simulator requirements in Appendix H to Part 121, the FAA is setting up an inflexible set of requirements which are specific enough to stifle new simulator technology, yet not specific enough to fully define the type of simulator which will be acceptable for approval. Rather, the FAA should delete or dramatically reduce the Appendix H proposal and deal with specific simulator requirements in an advisory circular which can be amended more readily.

*Response*—It is essential not to stifle the development of new simulator technology. However, including minimum simulator requirements in an appendix to the regulation will not adversely affect technological development. Neither should the simulator requirements be specified in minute detail. Appendix H sets forth minimum requirements for simulators used under the advanced simulaiton plan. Minimum requirements which can be objectively measured are selected to guarantee a minimum degree of simulator sophistication and capability. While the setting of a minimum standard may result in some operators seeking merely to satisfy the minimum, the plan encourages manufacturers and operators alike to continue to strive for improvements to achieve advances

[1] The FAA received one additional comment 2½ months after the close of the comment period. Under § 11.47 of the FAR, "late filed comments are considered so far as possible without incurring expense or delay." Accordingly, the comment is considered and discussed as comment 16.

beyond the minimum. The FAA will continue to monitor the advancements in simulation and is prepared to propose amendments to the regulation if it becomes necessary in the future. The FAA is committed, however, to establishing minimum simulator requirements to ensure a minimum simulator sophistication and capability before permitting the simulator training to be substituted for training in the airplane. Detailed specifications are not included to allow technological innovation and development. Where comments showed that the Appendix H was too restrictive, the specific proposal is addressed later in this section. Setting minimum simulator requirements through the public rulemaking process ensures the widest degree of participation in the development of the requirements and provides sufficient stability in the requirements so that operators can use informed judgment in planning for and investing in simulators which may take several years to be delivered.

2. *Comment*—Motion, visual, instrument system response. Increasing the speed (response time) of the motion, visual, and instrument systems to an absolute value of 150 milliseconds as stated in simulator requirement 10 in Phase II should not be a requirement of the advanced simulation plan. The important issue is ensuring that the response of the simulator is like the airplane simulated. Further, the FAA should not require a specific test for measuring response time because of differences between simulators made by different manufacturers.

*Response*—The commenter is correct. The 300 and 150 millisecond response time requirements listed in Phases I and II of Appendix H are intended to be tolerances over actual airplane response times, not absolute response times. By defining specific tests in the proposal, numerous commenters were misled into thinking that they represented absolute response times rather than tolerances over airplane response times. The sections in Appendix H dealing with response times are revised to clarify that they are times for the airplane to react plus 300 or 150 milliseconds, as applicable. The tests to determine the response time are also revised to describe and clarify an acceptable test procedure, to state the required outcome of the test, and to allow the use of an equivalent test approved by the Administrator. The FAA continues to maintain the importance of considering cue correlation, that is, the relative response of motion, visual, and instrument systems, as part of the simulator programing. Therefore, Phase II simulator requirement 11 requires that the motion response occur before the visual system response, but in no case before that of the airplane or later than 150 milliseconds after the airplane would respond under the same conditions. In actual operations the airplane would have to move before the visual scene would change. This is not necessarily true in the simulator. False cues can affect training effectiveness. These response times are intended to eliminate false cues caused by a significantly slower or faster response in the simulator than in the aircraft.

3. *Comment*—Handling characteristics (Feel). While handling characteristics or "feel" are referred to in the preamble of the proposed rule, their performance comparability is not specifically addressed. Control feel dynamics should be included as crieria which an advanced simulator must meet. Further, a requirement should be included for a subjective evaluation of such characteristics by pilots experienced in the airplane type simulated. The proposed rule's quest for purely objective evaluations is understood and appreciated, but the empirical experience of pilots must not be ignored.

*Response*—Control feel dynamics should be included in the simulator requirements and, as adopted, Appendix H includes them. Significant benefits are to be gained from a simulator evaluation conducted by a pilot who is rated in the airplane type simulated. A pilot rated in the airplane can tie together all of the objective tests results to reach a final decision on approval of the simulator. For this reason, simulator evaluations under the plan will be conducted by an FAA national simulator evaluation team which will include pilots rated in the aircraft simulated. The requirement for control feel added as simulator requirement 10 to Phase II of Appendix H is an objective test comparing the simulator to the actual airplane. During the development of Notice 79–18, the FAA was unaware of the existence of an objective test in this area. Commenters have shown that an objective test is now possible. Due to the accuracy and impartiality of objective testing, an objective test comparing the dynamic control forces of the simulator to that of the aircraft would greatly enhance the quality of control feel of advanced simulators.

4. *Comment*—Representative vs. universal programing. Representative programing should be acceptable in presenting training situations under Phases II and III of the advanced simulation plan.

*Response*—Representative programing involves using specific data samples to present training situations which are "representative" of selected portions of actual operational situations as compared to presenting the full or "universal" actual situation. This might be illustrated in the case of a simulation of runway contamination. Representative programing would begin with actual airplane data for dry runway stopping distances and would apply other data-gathering techniques so that an accurate yet representative wet and icy runway could be presented in simulator training. Universal programing would require airplane flight test data for every type of runway surface and contaminant to exactly duplicate any actual operational situation. Universal programing as defined here is impractical in many situations.

The advanced simulation plan goal is to achieve a *capability* to present any actual situations which may be involved in a training program today or in the future, but not a *requirement* to actually present all situations at all times. With this in mind, visual requirement 4 in Phase II and requirement 3 in Phase III of Appendix H are revised to clarify the phase of flight intended for each requirement. Operators should be aware, however, that simulators must be programed to present the actual situations required by Appendix H and by their training programs. As training programs change, simulator programing must be changed as well. By expanding simulator capabilities under the advanced simulation plan, an operator has this flexibility.

5. *Comment*—Minimum equipment list (MEL). An MEL is essential to a viable simulator training program, but the aircraft MEL is inadequate and would unnecessarily restrict the use of the simulator. A flight simulator includes many features which are not part of the real aircraft, such as an instructor's console, motion system, and visual system, but are critical for training depending on the type of training and checking being conducted. The FAA should therefore consider an MEL specifically designed for the simulator. Further, the requirement to repair failed components within 24 hours is arbitrary and unnecessary. Economics will dictate the quickest simulator repair possible since the operator will be forced to train in the airplane if the simulator is not repaired.

*Response*—The commenter is correct and the MEL requirements in the introduction to Appendix H are changed to allow operation under an MEL which has been approved for the simulator by

the Administrator. For standardization purposes, the MEL will include simulator components and indicate the type of training or checking that is authorized if that component is inoperative. To accomplish this, the component will be placed in one of the following categories with any remarks applicable to that component:

1. No training or checking.
2. Training in specific maneuvers.
3. Certification and checking.
4. Line Oriented Flight Training (LOFT).

The motion system is required for all training and checking, the visual system is required at each occupied pilot position, and certain components, such as those associated with thunderstorm presentations, may be required for certain portions of recurrent training but may not be required for certification checking. Components such as these should be annotated in the remarks section of the simulator MEL. However, if an instructor is occupying one of the pilot seats, the side window visual display of that seat may be inoperative. Since § 121.407 requires simulator discrepancies to be written into a daily discrepancy log, this log can be compared against the simulator MEL to show operational compliance with the MEL.

6. *Comment*—Check airman or instructor experience and training. There is no argument that experienced instructors and check airmen must be used in the advanced simulation program or that they may require special training. However, the experience and training proposed throughout Notice 79–18 should not be the only acceptable means. Rather, each operator should be allowed to submit a plan for selecting and training these personnel. This would provide flexibility so that the industry could operate within existing labor agreements and overall training programs.

*Response*—The comment has merit, in general, but a minimum instructor or check airman experience level and training time is being set for training conducted under the advanced simulation plan. The most sophisticated simulator can be of little value without an experienced, well-trained instructor or check airman to operate it. Because simulators will be used to totally replace the airplane in the areas allowed under a particular phase of the advanced simulation plan, the FAA wants to ensure that the instructors or check airmen involved are given a minimum amount of initial and recurrent training. Some flexibility over what was proposed in Notice 79–18, however, is warranted. Therefore, Appendix H is revised to consolidate all check airman and instructor experience and training requirements into an introductory section. The section requires each operator involved in Phase II, IIA, and III training to operate according to an advanced simulation training program approved by the Administrator which, in part, shows the following:

a. 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 pilot is instructing or checking.

b. 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 in which that person is instructing or checking. This requirement ensures that the instructor or check airman is participating in the operator's line operations and can bring current experience to the training program.

c. 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, operation of simulator controls (including environmental and trouble panels), limitations of the simulator, and minimum equipment required for each course of training.

7. *Comment*—First officer to captain upgrade experience requirements. The 5,000-hour flight time experience requirement set forth in Phase II of the proposal for pilots who have not previously flown the airplane type is excessive. Requiring 1,000 to 2,500 hours is more reasonable in that only 500 hours are required for pilots who have previously flown the airplane type.

*Response*—The comment has merit. The requirement ensures that a pilot has adequate experience to upgrade into an airplane which the pilot has never flown. The comment described above represents the views of an industry organization and a pilot professional group. Both have extensive expertise in evaluating pilot experience levels. Reconsidering the 5,000-hour proposal in light of the comment and considering the 500-hour requirement for pilots who have previously flown the same type of airplane, the FAA has concluded that the proposal should be modified. Phase II, Item 2(b)(ii), therefore, is changed to require a total of 2,500 hours of pilot experience on any two airplanes of the same group prior to upgrade under Phase II into another airplane in that group. This provides an acceptable level of safety. Pilots not meeting any portion of the eligibility requirements for upgrade under Phase II must receive initial training which must be conducted in the airplane or a Phase III simulator.

8. *Comment*—Computer capability. Many approaches exist relative to measurement of computer capabilities, making a single standard of acceptance difficult to apply to all computer manufacturers. The FAA should therefore change the reference in Phase II simulator requirement 7 of Appendix H to require simulator computer capacity, accuracy, resolution, and dynamic response to meet Phase II demands.

*Response*—A minimum simulator computer capacity, accuracy, resolution, and dynamic response is necessary to meet Phase II demands, especially with regard to fidelity of simulation. Setting objective criteria which ensure a certain level of computer sophistication lets the FAA ensure with more certainty that the simulator is capable of meeting varying training demands. The regulation requires "resolution *equivalent to* that of at least a 32-bit word length computer . . ." for critical aerodynamic programs. There are many different approaches which may be used to satisfy this requirement, including using 16-bit word computers with double precision software, or 24-bit computers with floating point software, for example. In this context, under Phase II of the advanced simulation plan, a computer which can show a minimum capability equivalent to or greater than a 32-bit computer is acceptable.

9. *Comment*—Built-in test procedure or equipment. Item 3 of the Phase II visual system requirements asks for a built-in test procedure. Items 5 and 6 of the Phase III simulator requirements ask for self-testing and diagnostic analysis capabilities. Do these requirements refer to procedures for testing the simulator or equipment which will automatically test the equipment? Fully automated test equipment for visual systems, if available, will not be economically feasible.

*Response*—These Phase II and III requirements were misunderstood by several commenters. The Phase II built-in visual test procedure was conceived to be a test procedure aided by a software model which could be entered into the visual system computer to assist the FAA and the operator in quickly

evaluating the visual system. The test procedure could consist of a test pattern or series of test patterns designed so that an inspector or maintenance technician could sit in the pilot seat and visually confirm the visual system color, Runway Visual Range (RVR), focus, intensity, level horizon, and attitude as compared with the simulator attitude indicator. There would be a software model within the computer so that special test equipment would not need to be brought into the simulator. The test procedure would be aided by a special visual system program to facilitate a quick and reasonably accurate evaluation of the visual system at each pilot's position and between pilots' positions. This requirement is designed to quickly pick up visual system errors and would not replace the very involved and precise visual system tests that the operator needs to perform to align the visual system.

The Phase III simulator requirements concerning self-testing and diagnostic analysis require fully automatic testing of simulator hardware and software and include a printout of simulator malfunctions as they occur. The automatic testing described in Phase III refers to the tests required for FAA initial and recurring approval and not necessarily complete testing of all software and circuitry. As simulator technology advances, this requirement will be essential for the FAA to effectively evaluate and monitor an operator's simulators. The self-testing requirement will provide more accurate data for comparing the simulator with the airplane and will allow a much more thorough evaluation in less time. This will result in benefits to the operator by reducing simulator down time. Diagnostic printouts will be in enough detail to be compared with the simulator MEL to determine the training status of the simulator each day, and will facilitate recordkeeping which will assist the FAA's surveillance of the operator's approved advanced simulation training program. The diagnostic printouts must be retained by the operator as part of the daily discrepancy log already required by § 121.407(a)(5) to show MEL compliances between recurring simulator evaluations. Appendix H, Phase III, simulator requirement 5, is revised to clarify this requirement.

10. *Comment*—Phase II visual system field of view. Some commenters favored an expanded field of view up to 90°. Others disagreed stating that exprienced airmen only need a limited field of view.

*Response*—A field of view of at least 75° horizontal is essential to a realistic visual presentation. Such areas as roll rate, landing, circling approaches, and ground taxiing maneuvers are greatly enhanced by expanded fields of view. In visual requirement 5 of Phase II, visual gaps may occur only as they would in the airplane simulated or as required by visual system hardware. Because the visual system dramatically impacts the reality of the simulator training experience, it is important that multiple visual system displays be edge-matched and designed with appropriate visual overlaps so that visual system gaps do not occur except as they would in the airplane. The size and location of different airplane windows, however, may require some shifting of visual system displays (which may be smaller than the actual window) so that, for example, the pilot can keep the runway in sight through a side window on a circling approach. Visual system hardware may therefore produce a slight gap in a certain portion of the field of view which cannot be avoided. Under these circumstances, a slight gap "required by visual system hardware" may be approved if the Administrator finds that the simulation is not adversely affected. The vertical field of view shall be 30° minimum. The visual system should be aligned so that the visual cutoff angle is accurate at the lower edge of the presentation and the upper edge of the presentation allows sufficient field of view above the horizon to see buildings and obstacles on the ground without distracting visual restrictions.

11. *Comment*—Visual effects. Visual effects such as weather presentations should be limited to specific phases of flight. Further, the Phase II visual requirement for partial obscuration of ground scenes (Item 4) should be deleted because visual systems are unable to portray curved lines and therefore clouds will be unrealistic.

*Response*—Requirements involving visual effects should be described according to a specific phase of flight. This point was also described in Comment No. 4. Within the context of a final approach to landing, however, the requirement for partial obscuration of ground scenes is valid. Most actual instrument approaches involve flying through scattered to broken cloud decks where the ground is visible but the runway is obscured by clouds. This results in "duck under" accidents because pilots go below minimum altitudes to see the runway, causing the airplane to contact an obstruction or land short of the runway. With the Phase II partial obscuration requirement, training designed to provide pilot experience in this area will be possible and safety will be enhanced.

While curved lines are difficult to produce in today's visual systems, a combination of trapezoidal occulting and reduced visibility could provide a realistic effect. Simulator manufacturers have assured the FAA that this requirement is not unreasonable and is within today's state-of-the-art.

12. *Comment*—Daylight visual system. There appears to be only two, or possibly three, valid user-defined requirements for a daylight visual system. They are:

a. The ability to realistically portray the difficult runway environment acquisition problem of a daytime low-visibility approach.

b. The ability to allow a cockpit lighting level in which pilots can accurately read charts and approach plates without undue diversion of attention from other flying tasks.

c. Some argue that for inexperienced pilots the daylight environment is less threatening and allows for more rapid orientation during visual approaches and landings. It is presumably for this reason that daylight visual systems are required by the proposed rule for initial *trainees.*

Due to the voluminous technical specifications required to define an adequate system, the definition of a daylight visual system should be in general operational terms rather than technical terms. The proposed rules sets forth only a few discrete technical specifications, and thus inadequately describes a proper daylight visual system. Such an approach also allows a situation in which literal compliance with the rule might well produce, operationally, a totally inadequate daylight visual system. Additionally, several of the specifications proposed (for example, surfaces and edges) discriminate against competent conceptual approaches to daylight visual simulation by certain manufacturers, and preclude technological advancement in a promising direction which may make the number of surfaces and edges meaningless. Other specifications in Notice 79-18 should not be assigned absolute values in the absence of known values for the many other variables in the daylight system. In fact, a requirement to literally meet only a few specifications could well result in a degradation of the dusk and night presentations which now enjoy great acceptance by the user pilots.

*Response*—Since the majority of air carrier flying time is during daylight hours and for the reasons cited above, the FAA is committed to encouraging

advances in the state-of-the-art in visual systems by requiring a daylight scene in the Phase III visual requirement 1. As described in Comment No. 1, objective simulator and visual system requirements are selected to guarantee a minimum degree of system sophistication and capability. Once the objective requirements are met, the visual system's ability to present the required visual effects will be evaluated subjectively. The system must, however, meet the objective criteria listed in Phase III to be considered a daylight system. Detailed specifications are not included to allow technological development. As technology progresses, any daylight visual system which can show equivalent capabilities in the objective areas described in Phase III will be considered for subjective approval.

In this regard, the requirement for 1,000 surfaces or 4,000 edges is amended to include the phrase "comparable in detail to that produced by 4,000 edges. . . ." The 1,000 surfaces or 4,000 edges are included to establish a minimum scene content capability. When technology progresses to where a specific number of edges and surfaces are unnecessary, a perceived scene content at least comparable in detail will be acceptable.

This scene content should be designed so that the airport and major landmarks can be recognized from 5 miles from the airport with detail unnoticably shifting to the runway environment as the airplane approaches landing. Detail on final approach should assist the pilot to visually asssess the airplane sink rate and provide cues to improve depth perception. The total daylight cockpit environment requirement in visual requirement 1 is also revised to include a provision that it must at least represent the amount of light in the cockpit on an overcast day. This has been done to clear up a misunderstanding that sunlight needs to shine in the window. The criteria included in the rule describe the lighting effect of an overcast day. This amount of light allows a pilot to read navigation charts without other cockpit lighting and allows an instructor to more easily observe the student's actions during simulator training.

13. *Comment*—Loss of Phase IIA training. The phrase "Any simulator not upgraded according to the operator's approved simulator upgrade program will void the plan resulting in loss of all Phase IIA Training" in the introduction to Phase IIA is too encompassing and would end Phase IIA training on one aircraft if a simulator for a different aircraft were not upgraded as proposed in the plan. It should be changed to read: "Any simulator not upgraded according to the operator's approved simulator plan will result in loss of Phase IIA training for that aircraft type."

*Response*—Phase IIA is an interim program designed to provide economic incentive for operators upgrading a large segment of their simulator fleet. All simulators entered into the plan must be upgraded according to the plan. Plans should be realistic and be based on firm commitments. One objective of the advanced simulation plan is to issue the Part 61 airline transport pilot (ATP) certificate upon successful completion of the appropriate simulator check. However, a second objective is to upgrade operators' simulator capabilities to present realistic training in various abnormal and weather flight conditions which may be encountered during line operations. If an operator fails to meet its commitment to the approved plan, it has achieved the economic benefit expressed in the first objective because it has avoided the airplane flights. By not upgrading the simulator, however, it has failed to provide a simulator capable of achieving the second objective of the plan. Both objectives are essential to the plan.

14. *Comment*—Six-axis motion systems. Specifying a six-axis motion system could hamper advanced research and development of a superior method of providing motion cues. It is therefore recommended that this requirement be changed to read: "A system which provides motion cues equal to or better than those provided by a six-axis freedom of motion system."

*Response*—While the FAA is unaware of any technology more advanced than the six-axis system, a new system could be acceptable if better technology becomes available. The Phase II simulator requirement 4 is revised as recommended. However, the FAA will not approve a visual system instead of a motion system because visual systems are incapable of providing motion onset cues.

15. *Comment*—Psychological considerations. One important factor has been overlooked in the study contained in the NPRM; that is, the psychological considerations of flight. An atmosphere of complacency is prevalent while operating a simulator irrespective of its sophistication. This psychological phenomenon is present because of the knowledge that, regardless of what mistakes are committed, the consequences of actions are negated because a simulator cannot crash.

*Response*—In point of fact, almost the exact opposite is true. Pilots do not fly airplanes out of a sense of fear. Further, actual airplane training flights are not conducted in adverse weather conditions. A flight instructor would not intentionally allow a trainee to get the airplane into a position which would jeopardize safety. Simulator training on the other hand is designed to facilitate training in varying environmental conditions and to let the trainee learn from mistakes. If a pilot makes a tragic mistake in a simulator, the simulator will dramatically simulate a crash and there is no doubt as to who made the mistake. The pilot's self esteem, peer pressure, and the pressure of being observed by one's employer and possibly the FAA can exceed the psychological pressure of flying the airplane. Appendix H and § 121.433 will continue to require line operating experience which ensures that each new airline captain is supervised by a company check pilot who is serving as pilot in command on the new captain's first flights on the line.

16. *Comment*—The plan is unfair and unsafe. One commenter opposes the proposed advanced simulation plan because the plan is deficient in the following respects: (1) The plan allows for the increased use of simulators without showing that it will not decrease safety; (2) The plan phases in the use of simulators too fast relative to existing and potential simulator technology; and (3) The plan fails to take into account the ultimate limits on the use of simulators.

*Response*—The main thrust of the advanced simulation plan is to improve safety by encouraging operators to upgrade their simulators and to produce better-trained flightcrews. In additon to the lengthy discussion of safety benefits in this preamble and Notice 79-18, the notice (see 44 FR 65552, column 1; November 13, 1979) references two FAA operational studies which helped to show that existing upgrade and transition training requirements can be accomplished in simulators which are not as sophisticated as those required in the advance simulation plan. Further, NASA has dramatically illustrated the ability of a pilot to successfully accomplish total training in a simulator as evidenced by its putting several men on the moon without having flown in the craft before. Commenters from all sides of the issue, including air carriers, pilot organizations, airline passenger organizations, and the National Transportation Safety Board, support the advanced simulation plan. This

commenter provided no data to show how safety would be compromised.

With regard to point 2, simulators are only a portion of a total training program which must be approved for the operator. With regard to the simulator, the three phases of the advanced simulation plan are designed to provide incentives to upgrade the simulators to a level which results in the safety benefits described under point 1. Simulator technology for Phase II is currently available to the industry and Phase III will be available within 5 years. By presenting a complete plan for simulator upgrade, it will be advantageous to airplane operators to introduce this technology into their training programs. If a complete plan is not presented, or if the timing expressed in the plan is altered, the training improvements needed to provide for safer flight operations will not be achieved.

Point 3 was discussed previously as Comment 15.

In developing this plan, the FAA gave full consideration to section 601(b) of the Federal Aviation Act of 1958, which states that the "Administrator shall give full consideration to the duty resting upon air carriers to perform their services with the highest possible degree of safety in the public interest. . . ." The rule is consistent with that statutory requirement.

### Points of Clarification

In addition to the major points raised by commenters, numerous points of clarification were raised concerning the interpretation of technical requirements. Thus, Appendix H is amended in several areas to clarify wording proposed in Notice 79-18. These points include consolidating all requirements common to several phases of the plan into the introduction of Appendix H and making the following minor changes to wording used in the Notice:

1. Phase II, "Training and Checking Permitted," is amended to show that transition training is for all pilot positions, not just pilot in command.

2. Phase II, Simulator Requirement 7, is amended to delate "and Phase III Demands" which is inappropriate in Phase II.

3. Phase II, Visual Requirement 1, is amended to clarify that at least three specific airport representations must be included in the simulator but that all airport representations need not be specific. Also "a capability of" ten levels of occulting is added to this requirement to show that each visual scene need not have ten levels if it is inappropriate.

4. Phase II, Visual Requirement 5, is amended to state that both visual systems shall "be able to" be operated. This clarifies the intent that pilot visual systems may be included in the MEL, but when operative, must work in both pilot positions.

### The Amendment

Accordingly, Parts 61 and 121 of the Federal Aviation Regulations (14 CFR Parts 61 and 121) are amended as follows, effective July 30, 1980.

## PART 61—CERTIFICATION: PILOTS AND FLIGHT INSTRUCTORS

1. By revising § 61.157 by adding a new paragraph (e) to read as follows:

**§ 61.157 Airplane rating: Aeronautical skill.**

* * * * *

(e) An approved simulator may be used instead of the airplane to satisfy the in-flight requirements of Appendix A of this Part, if the simulator—

(1) Is approved under § 121.407 of this chapter and meets the appropriate simulator requirements of Appendix H of Part 121; and

(2) Is used as part of an approved program that meets the training requirements of § 121.424 (a) and (c) and Appendix H of Part 121 of this chapter.

## PART 121—CERTIFICATION AND OPERATIONS: DOMESTIC, FLAG, AND SUPPLEMENTAL AIR CARRIERS AND COMMERCIAL OPERATORS OF LARGE AIRCRAFT

2. By revising § 121.407 by adding a new paragraph (c) to read as follows:

**§ 121.407 Training program: Approval of airplane simulators and other training devices.**

* * * * *

(c) An airplane simulator may be used instead of the airplane to satisfy the in-flight requirements of §§ 121.439 and 121.441 and Appendices E and F of this Part, if the simulator—

(1) Is approved under this section and meets the appropriate simulator requirements of Appendix H of this Part; and

(2) Is used as part of an approved program that meets the training requirements of §121.424 (a) and (c) and Appendix H of this Part.

3. By adding a new Appendix H to Part 121 which reads as follows:

### Appendix H—Advanced Simulation Plan

This Appendix provides guidelines and a means for achieving flightcrew training an advanced airplane simulators. This plan for achieving the goal of advanced simulation consists of three major phases and an interim phase to facilitate the plan's implementation. The three-phase plan is to provide standards for a progressive upgrade of airplane simulators so that the total scope of flightcrew training can be enhanced. Each phase builds on the preceding phase so that the final advanced simulation phase includes all the requirements of preceding phases. This Appendix describes the simulator and visual system requirements which must be achieved to obtain approval of certain types of training in the simulator. The requirements in this Appendix are in addition to the simulator approval requirements in § 121.407. Each simulator which is used under this Appendix must be approved as a Phase I, II, or III simulator, as appropriate.

To obtain FAA approval of the simulator for a specific phase, the following must be demonstrated to the satisfaction of the Administrator:

1. Documented proof of compliance with the appropriate simulator, visual system, and additional training requirements of this Appendix for the phase for which approval is requested and preceding phases, if appropriate.

2. An evaluation of the simulator to ensure that its ground, flight, and landing performance matches the type of airplane simulated (Phase I Approval Tests).

3. An evaluation of the appropriate simulator and visual system requirements of the phase for which approval is requested and preceding phases, if appropriate.

### Changes to Simulator Programing:

While a need exists for some flexibility in making changes in the 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:

1. 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 FAA office responsible for conducting the recurrent evaluation of that simulator.

2. If the FAA does not object to the planned change within 21 calendar days, the operator may make the change.

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

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

5. The FAA may examine supporting data or flight check the simulator, or both, to ensure that the aerodynamic quality of the simulator has not been degraded by any change in software programing.

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

**Simulator Minimum Equipment List (MEL):**

Because of the strict tolerances and other approval requirements of Appendix. H simulators, the simulator can provide realistic training with certain nonessential items inoperative. Therefore, an operator may operate its simulator under an MEL which has been approved by the Administrator for that simulator. The MEL includes simulator components and indicates the type of training or checking that is authorized if the component becomes inoperative. To accomplish this, the component is placed in one of the following categories along with any remarks applicable to the component's use in the training program:

1. No training or checking.
2. Training in specific maneuvers.
3. Certification and checking.
4. Line Oriented Flight Training (LOFT).

**Advanced Simulation Training Program:**

For an operator to conduct Phase II, IIA, or III training under this Appendix all required simulator instruction and checks must be conducted under an advanced simulation training 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. The advanced simulation training program shall include the following:

1. The operator's initial, transition, upgrade, and recurrent simulator training programs and its procedures for re-establishing recency of experience in the simulator.

2. 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.

3. 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 pilot is instructing or checking.

4. 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.

5. 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, operation of simulator controls (including environmental and trouble panels), limitations of the simulator, and minimum equipment required for each course of training.

6. 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 back at one airport to arrival at another. Another flight segment contains training in appropriate abnormal and emergency flight operations.

7. For operators training under Phase IIA, the additional training requirements of that phase.

**Phase I**

*Training and Checking Permitted*

1. Regency of experience (§ 121.439).
2. Night takeoffs and landings (Part 121, Appendix E).
3. Landings in a proficiency check without the landing on the line requirements (§ 121.441).

*Simulator Requirements*

1. Aerodynamic programing 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 guide to verify simulator data with actual airplane flight test data, and provide simulator performance tests for Phase I initial approval.

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

*Visual Requirements*

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 lags.

**Phase II**

*Training and Checking Permitted*

1. For all pilots, transition training between airplanes in the same group, and for a pilot in command the certification check required by § 61.157 of this chapter.

2. Upgrade to pilot-in-command training and the certification check when—

a. The pilot—(i) Has previously qualified as second in command in the equipment to which the pilot is upgrading;

(ii) Has at least 500 hours of actual flight time while serving as second in command for the operator in an airplane in the same group; and

(iii) Is currently serving as second in command with that operator in an airplane in this same group; or

b. The pilot is employed by an airplane operator and—(i) is currently serving as second in command with that operator in an airplane of the same group;

(ii) has a minimum of 2,500 flight hours as second in command in airplanes of the same group with that operator; and

(iii) has served as second in command on at least two airplanes of the same group with that operator.

Pilots qualifying under paragraph 2.b. of this paragraph may upgrade to another airplane in that group in which that pilot has not been previously qualified.

*Simulator Requirements*

1. Representative crosswind and three-dimensional windshear dynamics based 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.
f. 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 based on airplane related data.
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 OMEGA, if applicable.
6. Means for quickly and effectively testing simulator programing and hardware.
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 modification.
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.
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.
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 but 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.

*Visual Requirements*

1. Dusk 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.
2. Radio navigation aids properly oriented to the airport runway layout.
3. Test procedures to quickly confirm visual system color, RVR, focus, intensity, level horizon, and attitude as compared to the simulator attitude indicator.
4. For the approach and landing phase of flight, 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.
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.

**Phase IIA**

*Interim Simulator Upgrade Plan for Part 121 Operators*

Under Phase IIA, any Part 121 operator may conduct Phase II training for 3½ years from the date it was approved for Phase I in a simulator approved for the landing maneuver under Phase I. 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 a carrier's upgrade plan to be acceptable, it must—
1. Be submitted to the FAA before July 30, 1981.
2. Show which simulators will be upgraded to Phase I requirements and their projected upgrade dates;
3. Show that these simulators will meet Phase I requirements before January 30, 1983.
4. 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 be replaced with, simulators which meet Phase II or III requirements and—
a. Show which simulators will be upgraded to, or replaced with, simulators which meet phase II or III requirements; and
b. Show that each of these simulators will meet Phase II or III requirements within 3½ years after the date it is approved for Phase I; and
5. Include an advanced simulation training program which meets the requirements of this appendix.

To conduct Phase IIA training in a Phase I simulator, all required simulator instruction and checks must be conducted in a simulator as part of an advanced simulator training program approved for the operator, including the additional training requirements of this phase.

Phase IIA interim approval ends for each Phase I simulator listed in the operator's approved plan 3½ years after that simulator is approved for Phase IIA training. Approval of the plan is withdrawn if any simulator is not upgraded according to the operator's approved simulator upgrade plan. This results in the loss of all Phase IIA training for that operator. Extension of Phase IIA training will not be considered.

*Training and checking permitted:* Same as Phase II.

*Simulator requirements:* Same as Phase I.

*Visual requirements:* Same as Phase I.

*Additional training requirements:*

1. In addition to the simulator training and the simulator certification and

proficiency check, and before the line operating experience training, participating flight crewmembers must complete a 4-hour Line Oriented Flight Training Course in the simulator to prepare them to perform line duties.

2. Each participating pilot in command must be given operating experience in the airplane to include 5 landings and 25 flight hours, and each second in command must be given 3 landings and 15 flight hours of line experience at his or her crew station under the supervision of a check airman who meets the qualifications of paragraph 3 and who is seated in the other pilot's position.

3. Each participating line check airman must be given an approved 4-hour training course to familiarize him or her with the Phase IIA program and to emphasize his or her role in the program. He or she shall also be qualified to provide both line and proficiency checks or be a line check airman who has successfully completed an approved simulator check airman course.

**Phase III**

*Training and Checking Permitted*

Except for the requirements listed in the next sentence, all pilot flight training and checking required by this Part and the certification check requirements of § 61.157 and Appendix A of Part 61 of this chapter. The line check required by § 121.440, the static airplane requirements of Appendix E of this Part, and the operating experience requirements of § 121.434 must still be performed in the airplane.

*Simulator Requirements*

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 simulator 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 atmospheric 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 sounds. The sounds shall be coordinated with the weather representations required in visual requirement No. 3.

4. Self-testing for simulator hardware and 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).

*Visual Requirements*

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 produced by 4,000 edges or 1,000 surfaces for daylight and 4,000 light points for night and dusk scenes, 6-foot lamberts of light at the pilot's eye (highlight brightness), 3-arc minutes resolution for the field of view at the pilot's eye, and a display which is free of apparent quantization and other distracting visual effects while the simulator is in motion. The 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 on the pilot's navigation instruments.

(Secs. 313, 601, 603, 604, Federal Aviation Act of 1958, as amended (49 U.S.C. 1354, 1421, 1423, 1424); sec. 6(c), Department of Transportation Act (49 U.S.C. 1655(c)))

**Note.**—The FAA has determined that this document involves a regulation which is not significant under Executive Order 12044 as implemented by DOT Regulatory Policies and Procedures (44 FR 11034; February 26, 1979). A copy of the final regulatory evaluation prepared for this action is contained in the regulatory docket. A copy of it may be obtained by contacting the person identified above under the caption "For Further Information Contact."

Issued in Washington, D.C., on June 24, 1980.

**Quentin S. Taylor,**

*Deputy Administrator.*

[FR Doc. 80-19492 Filed 6-27-80; 8:45 am]

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**14 CFR Part 121**

**[Docket No. 19758; Amdts. Nos. 61-69 and 121-161]**

## Advanced Simulation

*Correction*

In FR Doc. 80-19492 appearing on page 44170 in the issue of Monday, June 30, 1980, make the following corrections:

(1) On page 44183, in the third line of Appendix H of Part 121, "... training an advanced airplane ..." should have read "... training in advanced airplane ..."

(2) In the first column of page 44184, complete the fifth line under **Advanced Simulation Training Program** as follows "... training program which is approved by the Administrator for the operator. This program [must also ensure ...]".

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