## Flight Simulation Device Qualification Guidance

# Windshear – Training and Simulator Requirements

FSTD Guidance Bulletin 09-04

**Purpose:** This bulletin provides additional background and clarification of (AC)120-40B, Appendix 5; (AC)120-40C, Appendix 6; and 14 CFR Part 60, Appendix A, Attachment 5 for those Sponsors requesting qualification of a Level C or D Flight Simulator Training Device (FSTD) for Windshear Training.

**Background:** Initially in the 1980's, discussions regarding windshear training were limited to Part 121 aircraft. Note the following references. According to 14 CFR Part 121.358, Low-Altitude Windshear System Equipment Requirements, the following airplane types must be equipped with "…either an approved airborne windshear warning and flight guidance system, an approved airborne detection and avoidance system, or an approved combination of these systems…"

1. A-300-600;
2. A-310, all series;
3. A-320, all series;
4. B-737-300, -400, and -500 series;
5. B-747-400
6. B-757, all series;
7. B-767, all series;
8. F-100, all series;
9. MD-11, all series;
10. MD-80 series equipped with an EFIS and Honeywell-970 digital flight guidance computer.
11. Any airplane manufactured after January 2, 1991.

This section goes on to say that "…all other turbine-powered airplanes…" (Not listed above or that were manufactured prior to January 2, 1991) "…must be equipped with, as a minimum requirement, an approved airborne windshear warning system. These airplanes may be equipped with an approved airborne windshear detection and avoidance system, or an approved combination of these systems."

This section deals with Part 121 operations ***only***, and defines "turbine-powered airplanes" as including "turbofan-," "turbojet-," "propfan-," and "ultra-high bypass fan-powered" airplanes - but it specifically ***excludes*** "turbopropeller-powered" airplanes.

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With the original issuance of the rule, there was the possibility for an authorization to extend the compliance date for this windshear equipment requirement. This extension was tied to the compliance date established for TCAS II retrofit **[**Section 121.358(c)(2)**]** which, according to the table in Section 121.356(a), would not be later than December 30, 1993.

According to 14CFR Part 121.409(d), "…each certificate holder required to comply with Section 121.358… must use an approved simulator for each airplane type in each of its pilot training courses that provides training in at least the procedures and maneuvers set forth in the certificate holder's approved low-altitude windshear flight training program."

**Present Status:** The above discussion is strictly applicable to Part 121 requirements and does not apply outside of this Part. However, training conducted under Part 142 (and ***not*** for Part 121 purposes), or training for those operations conducted under Parts 91, 125, or 135, ***may*** include windshear training provided the simulator has been evaluated, found satisfactory, and recommended for such use.

**Recommended Training Program Requirements:**

The recommended training program, contained in the Windshear Training Aid[1], published by the FAA in February 1987, contains an "Example Windshear Training Program." Within this example, is a "Simulator Training Program" section. This section sets out Basic Exercises and Optional Exercises, as to when and where the training crew should encounter a windshear. These exercises are ***"suggested,"*** and are not required. They are described below:

**Basic Exercises:**

| | | |
|---|---|---|
| 1. | Takeoff - After Liftoff | During Initial Climb (5 examples given)<br>or<br>During Rotation***** (4 examples given) |
| 2. | Takeoff - On Runway | Prior to $V_R$ (3 examples given) |
| 3. | Approach | During ILS Approach (4 examples given) |

*****Airplane lifts off as shear is recognized.

**Optional Exercises:**

| | | |
|---|---|---|
| 1. | Takeoff (Complex) | Demonstrates real-world application of windshear techniques.<br>(1 example given) |
| 2. | Approach (Complex) | Demonstrates real-world application of windshear techniques.<br>(1 example given) |
| 3. | Stick Shaker Practice | Demonstrates basic airplane response near stall during windshear encounter and recovery.<br>(4 examples given - 2 takeoff, 2 landing) |
| 4. | Increase $V_R$ Speed | Demonstrates correct use of increased rotation speed precautionary technique.<br>(1 example given) |

As a reminder – The NSP does not approve windshear or other training programs. The windshear training program content will be submitted by the operator and approved by the Training Program Approval Authority (TPAA). The TPAA is the Principal Operations Inspector (POI), Training Center Program Manager (TCPM), and/or the assigned operations inspector at a Flight Standards District Office (FSDO), as appropriate, who exercises authority on behalf of the Administrator in approving the airplane flight-training program in which the simulator will be used. Before a windshear training program can be approved, the NSP must Qualify the FSTD for windshear training tasks. Further guidance for approval of low-altitude windshear training programs under parts 121 and 135 may be found in Advisor Circular (AC)120-50A.

**Qualification of Simulators Used for Windshear Training:**

The basic requirements for a simulator to be satisfactorily evaluated and qualified for windshear training are set out in Appendix 1, Section 2, Item O and Appendix 5 of Advisory Circular (AC) 120-40B; and Appendix 1, Section 2, Item O and Appendix 6 of Advisory Circular (AC) 120-40C for devices qualified under those criteria and the current rule, 14CFR part 60 Change 1, Appendix A, Table A1A, Item 2e and Attachment 5. Familiarity with these references is strongly encouraged.

The appendices above outline the requirement for a windshear compliance statement to be placed in the Qualification Test Guide (QTG) that will confirm characteristics of aerodynamic and environmental parameters including any windshear intensity factor used to automatically compensate for weight, temperature, and altitude changes. The source of the selected windshear models should also be disclosed, i.e. the FAA-Windshear Training Aid or other recognized source.[2] The requirements for these windshear models must "…provide cues necessary for recognition of the onset of a windshear phenomena and potential performance degradation that would require a pilot to initiate recovery procedures." The windshear recognition cues should include one or more of the following, as may be appropriate:[3]

1. Rapid airspeed change of at least ±15 knots.
2. Stagnation of airspeed during the takeoff roll.
3. Rapid vertical speed change of at least ±500 feet per minute.
4. Rapid pitch change of at least ±5 degrees.

Further, the "windshear models" available for use in the FAA-approved windshear flight training program must be adjustable in intensity (or other parameter to achieve the desired effect) so that when encountered, either of the following results may be achieved (at the option of instructor):

1. Airplane performance permits the pilot to maintain a satisfactory flight path.
2. Airplane performance does not permit the pilot to maintain a satisfactory flightpath (i.e., the airplane will crash).

Lastly, it is recommended that some variable level of turbulence be randomly selectable from the instructor operating station (IOS) for incorporation into any windshear training model. Such turbulence, however, should be disabled for the purposes of objective testing (See "Objective Evaluation" below).

**Objective Evaluation:** There are four (4) objective tests that are conducted as a part of the simulator evaluation for windshear training recommendation. The sponsor must submit two (2) of the "windshear models" available in the simulator (one takeoff and one approach). The simulator is flown through calm air (to observe/record performance without the presence of windshear) and then through the selected survivable windshear (to observe/record performance with the presence of windshear) for both the takeoff and the approach (Go-Around) case. In either case, the simulated aircraft should be at the same weight/balance, configuration and the same initial airspeed for both the calm and windshear-active tests. These parameters should fall within the dispatch limitations of the airplane. To provide consistent and repeatable results, random turbulence selectable

from the IOS or other sources should be disabled during objective testing. Turbulence that results from the windshear model, however, is to be expected, and no attempt should be made to neutralize turbulence from this source. Programmers modeling these objective test scenarios are encouraged to review pages 3.3-60 through 3.3-63.1 of the Windshear Training Aid that pertain to tuning and implementation.[4] The first scenario provides an appropriate example for the Approach case while the second is representative of a Take-off after Vr scenario. In either case, the tests must appropriately demonstrate the recognition cues (previously noted) *before* the escape maneuver for the aircraft being simulated[5] is executed. In either the Take-off or Approach winds-calm cases, it is acceptable and actually preferred to match the pitch demonstrated in the windshear escape maneuver (windshear active case) such that a more direct comparison of the other critical parameters (Airspeed, AOA and Rate of Climb) may be demonstrated.

Objective test results should, at a minimum, electronically record and plot time histories of the following parameters:

1. Indicated or calibrated airspeed.
2. Indicated vertical speed.
3. Pitch attitude.
4. Indicated or radio altitudes.
5. Angle of attack.
6. Elevator position.
7. Engine data (thrust, $N_1$, or throttle position).
8. Wind magnitudes (simple windshear model assumed – more complex models may require lateral, vertical, and longitudinal plots).

During recurrent evaluations, the results of these tests will be compared to the MQTG test results conducted initially and reviewed/accepted by the NSPM engineering staff. Further, these QTG windshear models must be available for use in the FAA approved windshear training program and should be clearly identified as QTG Models on the IOS for the purposes of subjective testing by an evaluating FAA inspector.

**Subjective Evaluation:** A functional evaluation of the simulator's performance in a windshear will be conducted. In this evaluation, the simulator will be flown in at least two (2) "windshear scenarios." One scenario will include parameters that enable the pilot to maintain a satisfactory flightpath and one scenario will include parameters that do not enable the pilot to maintain a satisfactory flightpath (i.e., the simulator will crash). The functional test may include the examination of other scenarios at the discretion of simulator evaluation specialist conducting the evaluation. The scenarios used for this

functional evaluation will be selected from the basic or optional exercises recommended in the Windshear Training Aid, if available, or from those scenarios approved and available to the instructors in the simulator for windshear flight training. It may be that only the scenarios used for objective testing are available for flight training and, consequently, available for functional testing.[6] If this is the case, the simulator evaluator will notify the TPAA of this limited capability as part of the NSPM response and make recommendation to the TPAA. In any event, windshear scenarios available on the IOS should be described in adequate detail to identify the specifics of the windshear encounter (i.e. flight regime, w/s trigger point, wind model detail, etc.)

**Windshear Equipment**: The equipment installed in the simulator relating to windshear warning and flight guidance or detection and avoidance, must operate and function the same or equivalently to the system(s) installed in the airplane for this purpose. This equipment must provide for the same alerting or advisory notification to the flight crew when the simulator is subjected to any environmental conditions that would have provided alerting or advisory notifications to the flight crew in regular operations in flight. The simulator must operate equivalently to the airplane in any circumstance approaching that of a windshear (i.e., rapid airspeed change of at least ±15 knots; stagnation of airspeed during the takeoff roll; rapid vertical speed change of at least ±500 feet per minute; or rapid pitch change of at least ±5 degrees) and not only when specific environmental models are used, or when specific aircraft configurations are selected, or when specific geographic models (including visual models) are selected. In the report to the TPAA, the simulator evaluator will state that the simulator performs correctly only when these circumstances are found to exist. Otherwise, the report will likely contain recommendations for limitations on windshear training and may, if circumstances warrant, conclude that the evaluation is unsatisfactory, resulting in windshear training ***not*** being authorized.

**Earlier Qualification Criteria:** For those FSTD's not required to comply with Advisory Circulars AC120-40B, AC 120-40C Draft, or the current rule 14 CFR Part 60, Change 1; it is expected that the FSTD will be in compliance with the requirements of 14 CFR Part 60, change 1 for recommendation of windshear qualification.

**Notes:**

[1] **The FAA Windshear Training Aid** is available from the National Technical Information Service (NTIS) may be found at: http://www.ntis.gov , or call the NTIS at (703) 487.4650.

[2] With regard to "Recognized Sources," see Advisory Circular (AC) 120-40B Appendix 1, Section 2, Item O; or Advisory Circular (AC) 120-40C Appendix 1, Section 2, Item O for devices qualified under those criteria; or the current rule, 14CFR part 60 Change 1, Appendix A, Table A1A, Item 2e.

[3] The requirement in Part 60 for "all" of the referenced cues includes the statement "…as may be appropriate for the appropriate portion of the flight envelope…" For example, "stagnation of airspeed during the takeoff roll" would not be appropriate for a windshear encounter on final approach; and "rapid vertical speed change of at least ±500 fpm" would not be appropriate for a windshear encounter on the takeoff roll. Additionally, the requirement in AC 120-40B describes "...one or more of the following, as may be appropriate..." which essentially would require more than one cue if that were appropriate.

[4] Where the windshear Statement of Compliance indicates use of the FAA-Windshear Training Aid, programmers are obligated to follow the guidelines published therein.

[5] A windshear escape maneuver is an aircraft specific pilot recovery technique that is achieved by pitching toward some initial target attitude and thrust. The objective of the recovery technique is to keep the airplane flying as long as possible and may subsequently entail flying at the threshold of stick shaker.

[6] Note that Part 60 requires four models to be available to the instructor (Table A1A, section 2.e.).