FSTD Guidance Bulletin 14-01

FSTD Evaluation Guidelines for Full Stall Training Maneuvers

Purpose:

This guidance bulletin provides FSTD Sponsors and flight training providers with FSTD evaluation guidelines and recommendations for conducting full stall training tasks in an FAA approved flight training program.

Scope:

This Guidance Bulletin provides an acceptable means, but not the only means of compliance with Title 14 Code of Federal Regulations (CFR) Part 60 pertaining to the Evaluation and Qualification of Flight Simulation Training Devices (FSTD) for use in FAA Approved Flight Training Programs. If an applicant chooses to utilize the approach described within this Guidance Bulletin, that applicant must adhere to all methods, procedures, and standards herein. Should an applicant desire to use another means, a proposal must be submitted to the National Simulator Program Manager (NSPM) for review and approval prior to implementation. This Guidance Bulletin does not change or create additional regulatory requirements and does not authorize changes in or deviations from existing regulatory requirements.

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1. Background

1.1. Purpose

The purpose of this guidance bulletin is to provide Flight Simulation Training Device (FSTD) sponsors with recommended FSTD evaluation procedures for training full stalls. This document is also provides FSTD evaluation guidance to those FSTD sponsors who intend to provide full stall training ahead of the five year mandatory compliance period described the Part 121 air carrier training rule.[1]

1.2. History

Recent legislation[2] and rulemaking on air carrier training programs will require flight crews to receive full stall and upset recovery training in FSTDs. Historically, stall training for air carriers has been limited to "approach to stall" training where recovery is initiated at the first indication of the stall (typically at the activation of the stall warning system or stick shaker). Since many FSTDs have not been fully evaluated to conduct full stall training and may lack the required fidelity to properly teach stall recognition cues and recovery procedures, additional evaluation may be necessary to avoid introducing an unintended safety risk through inappropriate or negative training.

1.3. Recent Working Group Efforts

Due to recent loss of control aircraft accidents and incidents, the FAA and industry have participated in a number of working groups to examine the training and simulation requirements needed to improve flightcrew response to inadvertent stalls and aircraft upsets. These working groups included:

- FAA/Industry Stall and Stick Pusher Working Group
- International Committee for Aviation Training in Extended Envelopes (ICATEE)
- Stick Pusher and Adverse Weather Event Aviation Rulemaking Committee (SPAW ARC)

[1] "Qualification, Service, and Use of Crewmembers and Aircraft Dispatchers" (RIN 2120-AJ00), Final Rule, Federal Register, 78 FR 67799 (November 12, 2013).
[2] Airline Safety and Federal Aviation Administration Extension Act of 2010 (Public Law 111-216).

- Loss of Control Avoidance and Recovery Training (LOCART) committee

These working groups were composed of subject matter experts in pilot training as well as subject matter experts in FSTD design, engineering, and validation. Through these working groups, the FAA was provided with numerous recommendations to improve the FSTD evaluation standards that support training in full stall maneuvers. These recommendations are under consideration as part of ongoing rulemaking work to modify the Part 60 FSTD qualification standards.[3]

1.4. FAA Advisory Circular AC 120-109 (Stall and Stick Pusher Training)

As a result of the recommendations from the Stall and Stick Pusher Working Group, the FAA published Advisory Circular AC 120-109 (Stall and Stick Pusher Training)[4] in August 2012. This AC provided best practices and guidance for training, testing, and checking pilots to ensure correct and consistent responses to unexpected stall warnings and stick pusher activations. Because of concerns regarding low fidelity representations of full stall behavior in simulators, a general recommendation was made in this AC against conducting full stall training unless the FSTDs are specifically evaluated to conduct such maneuvers. Specific areas of concern were cited in FSTD fidelity that could contribute to negative training:

- Lateral and directional handling characteristics at angles of attack above the activation of the stall warning system
- Stall buffet characteristics and onset speeds
- Handling characteristics in stall maneuvers other than objectively tested, wings level stalls (such as in high altitude cruise and turning flight conditions)

Advisory Circular 120-109 is currently pending revision to Change 1 (Stall Prevention and Recovery Training)

As a result of requirements of Public Law 111-216, AC 120-109 was revised to provide guidance for full stall prevention and recovery training. This AC will provide comprehensive guidance for the proper delivery of full stall training

[3] "Flight Simulation Training Device Qualification Standards for Extended Envelope and Adverse Weather Event Training" (RIN 2120-AK08), Department of Transportation Report on Significant Rulemakings, http://www.dot.gov/regulations/report-on-significant-rulemakings
[4] Copies of FAA Advisory Circulars may be downloaded at: http://www.airweb.faa.gov/

which mitigates the risk of negative training through a hands-on, instructor led demonstration, allowing the pilot experience all the aircraft's dynamic cues near and at full stall. This training should only be conducted in full flight simulators that have been evaluated in accordance with this Guidance Bulletin.

1.5. Current FSTD Qualification Standards

It is noted that most of the current and grandfathered FSTD qualification standards do, in fact, contain some objective and subjective testing requirements to a full stall and recovery. While the current minimum FSTD qualification standards may not adequately define a comprehensive evaluation of the stall characteristics that minimizes potentially negative training, the FAA recognizes that some FSTDs may have been programmed with the necessary fidelity to conduct such tasks or would require minimal modification to do so. The FSTD evaluation recommendations in this guidance document supplement the following existing requirements for the evaluation of stall characteristics in 14 CFR Part 60 (2008):

- Table A2A (Objective Testing Requirements), Test 2.c.8 - Stall Characteristics
- Table A2A (Objective Testing Requirements), Test 3.f.5 - Characteristic Motion Buffets: Buffet at approach to stall
- Table A3A (Functions and Subjective Testing Requirements), Section 6.a. - Maneuvers: High angle of attack, approach to stalls, stall warning, buffet, and g-break; takeoff, cruise, approach, and landing configuration.

2. FSTD Evaluation for Full Stall Maneuvers

2.1. General

The following section provides FSTD sponsors with recommendations to assess an FSTD's suitability to conduct full stall training tasks. This information is not intended to replace existing regulatory requirements in 14 CFR Part 60.

2.2. Aerodynamic Modeling (General)

2.2.1. The aerodynamic math model should be based upon data gathered from aircraft flight test, wind tunnel, or derived from reliable analytical or predictive methods.

2.2.2. The model validity should extend to at least ten degrees beyond the full stall angle of attack, which is either the critical angle of attack or the angle of attack for stick pusher activation, if installed.

2.2.3. Within the range of validity, the aerodynamic model should be programmed to account for the following typical stall characteristics where applicable by aircraft type. At angles of attack approaching the stall and beyond, the FSTD should, at a minimum, exhibit characteristic behavior of the aircraft as determined through subjective assessment by a qualified subject matter expert (SME) pilot with relevant experience in the aircraft.

- Degradation of static/dynamic lateral-directional stability
- Degradation in flight control effectiveness (pitch, roll, yaw)
- Uncommanded roll response
- Apparent randomness or non-repeatability
- Changes in pitch stability
- Stall hysteresis
- Mach effects
- Stall Buffet
- C.G. effects

2.3. Aircraft Systems

2.3.1. Autoflight systems (such as autopilots or autothrottles) should be programmed using aircraft or avionics systems manufacturer's data to ensure the system reacts correctly to an impending stall or fully stalled flight condition.

2.3.2. Where equipped, a stick pusher system or stall protection system should be modeled, programmed, and validated using the aircraft manufacturer's design data or other acceptable data sources. The model should account for stick pusher activation and cancellation logic as well as system dynamics, control displacements and forces as a result of the stick pusher activation.

2.3.3. Transient column forces resulting from stick pusher system activation should be measured and validated with flight test data or aircraft manufacturer design data. Recommended tolerances should be within ±5 lbs or 10% of the validation data.

2.4. Objective Evaluation

2.4.1. It is beyond the scope of this guidance document to mandate additional objective testing to validate FSTD stall characteristics. It is noted, however, that most FSTDs already have required objective stall validation tests in their FAA approved Master Qualification Test Guides (MQTGs). Additional parameters may be available in the existing objective test cases that would allow for an enhanced objective assessment of the FSTD's stall characteristics, particularly in the lateral/directional performance and handling qualities in an impending stall. It is recommended that FSTD sponsors use these existing objective test cases in determining stall training maneuvers that are most likely to have a high degree of fidelity.

2.5. Functions and Subjective Evaluation

2.5.1. An assessment of the FSTD's stall characteristics should be accomplished by a subject matter expert (SME) pilot with experience in the stall characteristics of the actual aircraft. Where the FSTD sponsor is unable to locate a qualified SME pilot with direct experience in the stall characteristics of the actual aircraft, other methods to assess the FSTD's stall characteristics may be acceptable:

- Subjective assessment using an SME pilot with experience in the stall characteristics of a similar aircraft make and model. This assessment should be complemented with aircraft OEM or other suitable documentation (such as flight test reports or aircraft certification data) that fully describes the stall characteristics of the simulated aircraft (see section 2.5.4 below).
- Subjective assessment of the aerodynamic model on the aircraft manufacturer's engineering simulator accompanied with objective proof of match (POM) test cases may be considered where the training simulator shares a common aerodynamic model with the engineering simulator. Additional checkout documentation should be supplied to enable the subjective evaluation of stall characteristics that may not be common to the shared aerodynamic model (such as subjective tuning of the FSTD's stall buffets).

2.5.2. The following stall entry conditions and aircraft configurations should be evaluated as necessary for training purposes:

- Stall entry at wings level (1 g)
- Stall entry at a constant altitude, turning flight of at least 25° bank angle

- Power-on stall entry (especially for propeller driven aircraft, but also for any aircraft where power effects significantly influence the wing and/or tail surfaces)
- Aircraft configurations of second segment climb, high altitude cruise (near performance limited conditions), and approach or landing.

2.5.3. For computer controlled aircraft (CCA), the FSTD should be evaluated in both "normal" and "non-normal" control modes. Reversion to degraded control laws (such as secondary, alternate, or direct control laws) should be conducted with consideration of potential failure scenarios that may be encountered in an operational environment or as necessary to support the operator's training requirements.

2.5.4. In addition to the performance and handling characteristics described in section 2.2.3, these additional aircraft characteristics and aircraft systems operations should be evaluated as applicable to the aircraft being simulated:

- Stall warning/stick shaker onset speeds
- Aircraft automation functionality (such as autopilot, autothrottle, or automatic stabilizer trim systems)
- Pitch Limit Indication (PLI)/speed warning system functionality
- Flight control effectiveness
- Aircraft stability
- Artificial control forces/load feel systems
- Automatic extension of leading edge devices (such as autoslat systems)
- Stall buffet
    - Stall buffet onset speed and relation to stall warning system activation and stall break
    - Stall buffet intensity and growth rate
    - Stall buffet characteristics (frequency and magnitude)
- Stall identification/stall protection systems (stick pusher/stick nudger)
    - System activation speed/angle of attack
    - System activation at high angle of attack rates
    - Stick pusher force/ability to override pusher forces
    - System cancellation logic
- Characteristics of the stall
    - Change in vertical speed and/or g-break
    - Pitch break
    - Flight control limitation
    - Uncommanded roll/yaw
    - Deterrent buffet

- Stall Recovery
  - Thrust/drag relationship
  - Engine effects on pitching moment
  - Stall hysteresis
  - Secondary stall/stall warnings
  - Representative altitude loss during stall recovery, particularly in high altitude performance limited conditions.

3. Additional Information

3.1. Implementation Considerations

3.1.1. FSTD sponsors are encouraged to coordinate with flight training personnel to ensure instructors understand the limitations of simulating aircraft dynamics during entry to and recovery from stalls. Since the stall recognition cues and handling characteristics of an aircraft can vary greatly as a function of how a particular stall is entered (wings level, turning flight, angle of attack rate, etc.) and the aircraft configuration (weight, C.G., flap settings, etc.), it is highly recommended that stall training maneuvers are restricted to those maneuvers that have been evaluated by an SME pilot or otherwise objectively evaluated against flight test data or other data.

3.1.2. It is recommended that the FSTD sponsor also review the NSP guidance published on FSTD evaluation of upset recovery training maneuvers[5]. This guidance bulletin has examples of recommended instructor operating station (IOS) enhancements that can provide instructor feedback on both the FSTD validation limits and the aircraft operational limits while conducting such maneuvers.

3.1.3. Where certain modifications (including modifications to an FSTD's aerodynamic model) are conducted on an FAA qualified FSTD, Part 60 requires that the FAA be notified of these changes as described in § 60.23. For further information, please see NSP Guidance Bulletin #11-02 (Notification of FSTD Modification and Validation Data Updates).

3.2. Air Carrier Training Programs

3.2.1. The FSTD evaluation recommendations in this guidance document are intended to assist air carriers in evaluating their FSTDs for use in conducting full stall training as described in § 121.423(c). FSTD Sponsors are strongly

[5] See NSP Guidance Bulletin #11-05, FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers.

encouraged to evaluate their FSTDs as described in this guidance bulletin before introducing such maneuvers into an FAA approved training program.

3.2.2. As stated previously, the FAA has initiated rulemaking to update the Part 60 FSTD evaluation standards to address simulator fidelity in full stall and other training maneuvers that were introduced in the updated part 121 air carrier training rule. The information in this bulletin is intended provide interim guidance to FSTD Sponsors which facilitates compliance with the new training requirements as soon as practicable ahead of the mandatory five year compliance period. While future changes to the Part 60 standards will likely supersede the guidance in this bulletin, these evaluation recommendations will provide a foundation to minimize the potential for inappropriate or negative training.