U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Stall and Stick Pusher Training

Date: 8/6/12

Initiated by: AFS-200

AC No: 120-109

Change:

The information contained in this advisory circular (AC) was developed based on a review of recommended practices developed by major airplane manufacturers, labor organizations, air carriers, training organizations, simulator manufacturers, and industry representative organizations. This AC does not provide guidance for full aerodynamic stall training, which industry and government stakeholders are now developing. Once developed, this AC will be revised to include that guidance.

The goal of this AC is to provide best practices and guidance for training, testing, and checking for pilots, within existing regulations, to ensure correct and consistent responses to unexpected stall warnings and stick pusher activations. This AC emphasizes reducing the angle of attack (AOA) at the first indication of a stall as the primary means of approach-to-stall or stall recovery. Additionally, this AC provides guidance for operators and training centers in the development of stall and stick pusher event training.

Core principals of this AC include:

- Reduction of AOA is the most important response when confronted with a stall event.
- Evaluation criteria for a recovery from a stall or approach-to-stall that does not mandate a predetermined value for altitude loss and should consider the multitude of external and internal variables which affect the recovery altitude. (Reference: Safety Alerts for Operators (SAFO) 10012, Possible Misinterpretation of the Practical Test Standards (PTS) Language "Minimal Loss of Altitude").
- Realistic scenarios that could be encountered in operational conditions including stalls encountered with the autopilot engaged.
- Pilot training which emphasizes treating an "approach-to-stall" the same as a "full stall," and execute the stall recovery at the first indication of a stall.
- Incorporation of stick pusher training into flight training scenarios, if installed on the aircraft.

/s/ for

John M. Allen
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CHAPTER 1. BACKGROUND INFORMATION

1-1. BACKGROUND. Based on accident review, a growing concern exists within the Federal Aviation Administration (FAA) and industry regarding loss of control (LOC) accidents. A growing causal factor in LOC accidents is the pilot's inappropriate reaction to the first indication of a stall or stick pusher event.

1-2. GENERAL. Evidence exists that some pilots are failing to avoid conditions that may lead to a stall, or failing to recognize the insidious onset of an approach-to-stall during routine operations in both manual and automatic flight. Evidence also exists that some pilots may not have the required skills or training to respond appropriately to an unexpected stall or stick pusher event. Stall training should always emphasize reduction of AOA as the most important response when confronted with any stall event. This AC provides best practices on training, testing, and checking of stall warnings, aerodynamic stalls, and stick pusher activations and recommended recovery procedures.

1-3. DEFINITIONS/TERMS. For the purpose of this AC, the following definitions and terms are provided:

a. Aerodynamic Stall. An aerodynamic loss of lift caused by exceeding the airplane's critical angle of attack.

b. Angle of Attack (AOA). The angle between the oncoming air, or relative wind, and some reference line on the airplane or wing.

c. Approach-to-Stall. Flight conditions bordered by stall warning and aerodynamic stall.

d. Crew Resource Management (CRM). Effective use of all available resources: human resources, hardware, and information.

e. First Indication of a Stall. The initial aural, tactile, or visual sign of an impending stall, which can be either naturally or synthetically induced.

f. Flight Simulation Training Device (FSTD). A full flight simulator (FFS) or a flight training device (FTD).

g. Instructor Operating Station (IOS). The interface panel between the FSTD instructor and the FSTD.

h. Landing Configuration. Starts when the landing gear is down and a landing flap setting has been selected during an approach until executing a landing, go-around, or missed approach.

i. Maneuver-Based Training. Training that focuses on a single event or maneuver in isolation.

j. Scenario-Based Training (SBT). Training that incorporates maneuvers into real-world experiences to cultivate practical flying skills in an operational environment.

k. Secondary Stall. A premature increase in AOA that results in another stall event during stall recovery, prior to a stable flight condition being established.

l. Stall Event. Anytime the airplane develops indications of an approach-to-stall or aerodynamic stall.

m. Stall Recovery Procedure. The manufacturer-approved airplane-specific stall recovery procedure. If a manufacturer-approved recovery procedure does not exist, the airplane-specific stall recovery procedure developed by the operator based on the stall recovery template in Chapter 4.

n. Stall Warning. A natural or synthetic indication provided when approaching a stall that may include one or more of the following indications:

(1) Aerodynamic buffeting (some airplanes will buffet more than others),

(2) Reduced roll stability and aileron effectiveness,

(3) Visual or aural cues and warnings,

(4) Reduced elevator (pitch) authority,

(5) Inability to maintain altitude or arrest rate of descent,

(6) Stick shaker activation (if installed),

o. Stick Pusher. A safety system that applies downward elevator pressure to prevent an airplane from exceeding a predetermined AOA in order to avoid, identify, or assist in the recovery of an aerodynamic stall.

p. Takeoff or Maneuvering Configuration. The airplane's normal configuration for takeoff, approach, go-around, or missed approach until all flaps/slats are retracted. Retractable landing gear may be extended or retracted.

q. Uncoordinated Flight. Flight with lateral acceleration, such as slipping or skidding in a turn.

r. Undesired Aircraft State. A position, condition, or attitude of an aircraft that reduces or eliminates safety margins, including low energy states.

1-4. RELATED REGULATIONS. Title 14 of the Code of Federal Regulations (14 CFR) parts 61, 91 subpart K (part 91K), 121, 125, 135, and 142.

1-5. RELATED FAA GUIDANCE (current edition):

- SAFO (10012), Possible Misinterpretation of the Practical Test Standards (PTS) Language "Minimal Loss of Altitude".
- Information Alerts for Operators (InFO) 10010, Enhanced Upset Recovery Training.

- Airline Transport Pilot and Aircraft Type Rating Practical Test Standards for Airplane
- Commercial Pilot Practical Test Standards for Airplane, Single-Engine Land (SEL), Multiengine Land (MEL), Single-Engine Sea (SES), Multiengine Sea (MES)
- Order 8900.1, Volume 2, Air Operator, Air Agency Certification.
- Order 8900.1, Volume 3, General Technical Administration.
- Order 8900.1, Volume 5, Airman Certification.
- AC 61-67, Stall and Spin Awareness Training.
- AC 120-51, Crew Resource Management (CRM).
- AC 120-90, Line Operations Safety Audits (LOSA).

1-6. RELATED REFERENCES:

- Airplane Upset Recovery Training Aid http://www.faa.gov/other_visit/aviation_industry/airline_operators/training/media/AP_UpsetRecovery_Book.pdf.
- Defensive Flying for Pilots: An Introduction to Threat and Error Management Ashleigh Merritt, Ph.D. and James Klinect, Ph.D. (The University of Texas Human Factors Research Project 1- The LOSA Collaborative), http://homepage.psy.utexas.edu/homepage/group/helmreichlab/publications/pubfiles/TEM.Paper.12.6.06.pdf.
- Culture, Threat, and Error: Assessing System Safety, Robert L. Helmreich, University of Texas Human Factors Research Project, The University of Texas at Austin http://homepage.psy.utexas.edu/homepage/group/helmreichlab/publications/pub%20project/252.pdf.

CHAPTER 2. STALL TRAINING PHILOSOPHY

2-1. GENERAL PHILOSOPHY. An effective stall training curriculum should provide pilots the knowledge and skills to avoid undesired aircraft states that increase the risk of encountering a stall event or, if not avoided, to respond correctly and promptly to a stall event.

2-2. TRAINING PHILOSOPHY. While basic aerodynamics and stall training are typically accomplished as part of a pilot's private, commercial, and airline transport pilot (ATP) certifications, it is important to reinforce this basic training throughout their careers. Training providers should ensure that pilots are thoroughly familiar with the characteristics associated with the specific airplane. Training providers should also understand that some pilots may need to unlearn previous stall recovery procedures based on their prior experience. This AC describes the approach-to-stall and stick pusher training that a pilot should receive when employed by an operator. This training may be completed either as stand-alone training or incorporated into other training areas (i.e., CRM, adverse weather training, etc.). Training providers should include approach-to-stall and stick pusher (if installed) training for pilots during:

- Initial training,
- Transition training,
- Requalification training,
- Differences training (if differences exist in stall warning or stall recovery procedure),
- Conversion training,
- Upgrade training, and
- Recurrent training.

2-3. INSTRUCTOR/EVALUATOR STANDARDIZATION. Instructors and evaluators should receive training in the subject areas contained in this AC. Knowledge of the subject areas contained in this AC ensures accurate stall training and minimizes the risk of negative training. Instructor/evaluator training should focus on the practical application of these principles and the evaluation of a pilot's understanding of the airplane's operating characteristics. Instructors/evaluators must have a clear understanding of the FSTD limitations that may influence the approach-to-stall training/testing/checking including:

- A particular FSTD's acceptable training envelope;
- G loading awareness/accelerated stall—factors absent from the FSTD's programming that could be experienced in flight and the effect on stall speed, airplane behavior, and recovery considerations;
- Motion cues—limitations of motion cues typically present in most simulators after the first indication of stall;
- Significant deviations from validated flight maneuvers could result in significant degradation in simulator fidelity.

2-4. TESTING/CHECKING.

a. Recovery Procedures. This AC emphasizes both recognizing a stall event and completing the proper approach-to-stall recovery procedure. Previous training and evaluation profiles that required a specific set of precise entry and recovery procedures have been replaced with realistic scenarios. Additionally, recovery profiles that emphasize zero or minimal altitude loss and the immediate advancement of maximum thrust have been eliminated. Emphasis is now placed on recognition and avoidance of those conditions that may lead to a stall event. Recovery procedures now emphasize:

- The immediate reduction of the airplane's AOA,
- Management of thrust, and
- Returning the airplane to a safe flying condition.

NOTE: Training providers should adjust their stall evaluation criteria as appropriate and train their evaluators in these changes. The primary goal of testing/checking should be to evaluate a pilot's immediate recognition and response to a stall warning and their timely, correct accomplishment of the stall recovery procedure.

b. Evaluation Parameters. The evaluator is responsible for establishing the flight conditions associated with the approach-to-stall configuration being evaluated. While the pilot may fly the entry profile, they are not being evaluated on the entry. The satisfactory completion of the event is based on the pilot's immediate response to a stall warning and the accomplishment of the proper stall recovery procedure.

c. Evaluation Criteria. Evaluation of the recovery from an approach-to-stall should no longer be based on altitude loss. Pilots should be evaluated on their timely response and effective use of available energy (i.e., altitude and speed) during stall recovery. The evaluator should consider the variables that are present at the time of the stall warning and their effect on the recovery. Evaluation criteria are:

(1) Prompt recognition of stall event,

(2) Correct application of the approach-to-stall recovery procedure, and

(3) Recovery of the airplane without exceeding the airplane's limitations.

d. Realistic Settings. In the FSTD, an approach-to-stall checking event may be maneuver-based or scenario-based with an entry altitude consistent with normal operating environments. The entry parameters, including weight and balance, should be within airplane limitations to ensure adequate performance for recovery from first indication of a stall. During training, the pilot may be asked, for demonstration purposes, to ignore some aural and visual indications of impending stall in order to practice the more difficult control movements needed to recover from the stick shaker. During testing/checking, the pilot should be evaluated on recovering at the first indication of a stall, even if it is based on an aural or visual indication that occurs before the stick shaker or stick pusher (if installed).

CHAPTER 3. TRAINING METHODOLOGY

3-1. GENERAL. The training methodology for approach-to-stall training should follow the building block approach of first introducing essential concepts and academic understanding before progressing to the practical application of those skills in the FSTD environment. Similarly, familiarity with airplane characteristics and development of basic recovery handling skills through maneuver-based training should precede their application in scenario-based training. This progressive approach will lead to a more complete appreciation of how to recognize an impeding stall, respond appropriately in situations of surprise or startle, and recover effectively when required. Training providers should develop training curriculums that provide pilots with the knowledge and skills to prevent, recognize, and recover from unexpected stall events. These training curriculums should contain the elements described in this chapter.

3-2. GROUND SCHOOL/ACADEMIC TRAINING.

a. Academic Knowledge. Academic instruction establishes the foundation from which situational awareness (SA), insight, knowledge, and skills are developed. Academic knowledge should proceed from the general to the specific. Having pilots share their experiences about stall-related encounters or events is a useful way of bringing theoretical knowledge into an operational perspective.

> **NOTE: The FAA strongly recommends incorporation of applicable sections of the Airplane Upset Recovery Training Aid on stall aerodynamics and high altitude stalls into air carrier stall training programs. The Airplane Upset Recovery Training Aid is available on the web at: http://www.faa.gov/other_visit/aviation_industry/airline_operators/training/media/AP_UpsetRecovery_Book.pdf.**

b. Airplane Training Curriculums. The following knowledge areas should be included in all airplane training curriculums:

(1) The understanding that a reduction of AOA is required to initiate recovery of all stall events (approach-to-stall and aerodynamic stall);

(2) An awareness of the factors that may lead to a stall event during automated and manual flight operations including:

- AOA versus pitch angle,
- Decaying airspeed,
- Weight,
- G loading,
- Bank angle,
- Center of gravity (CG),
- Thrust and lift vectors,
- Thrust settings and application of thrust,
- Autothrottle protection,
- Wind shear,

- Configuration,
- Altitude,
- Mach effects,
- Uncoordinated flight and improper use of rudder,
- Misuse of automation,
- Situational Awareness, and
- Contamination (ice).

(3) Recognition of the stall warning indications and understanding of need to initiate the stall recovery procedure at the first indication of a stall;

(4) Operation and function of stall protection systems in normal, abnormal, and emergency situations, including the hazards of overriding or ignoring stall protection system indications. Awareness of the factors that may lead such systems to fail, as well as degraded modes, indications, or behaviors that may occur with system failures;

(5) Effectiveness of control surfaces and the order in which the control surfaces lose and regain their effectiveness (e.g., spoilers, ailerons, etc.);

(6) Differences between transport category airplane certification and general aviation airplane certification regarding use of flight controls at high AOA. For example, transport category airplanes are certified to retain the ability to raise a wing, with full aileron deflection if needed, all the way up to stick shaker;

(7) Specific stall and low speed buffet characteristics unique to the airplane type and any implications for the expected flight operations and airplane-specific stall recovery procedure;

(8) Proper stall recovery procedure;

(9) Buffet boundary and margins in flight planning and operational flying;

(10) The necessity for smooth, deliberate, and positive control inputs to avoid unacceptable load factors and secondary stalls;

(11) Avoiding cyclical or oscillatory control inputs to prevent exceeding the structural limits of the airplane;

(12) Structural considerations, including explanation of limit load, ultimate load, and the dangers of combining accelerative and rolling forces (the rolling pull) during recovery;

(13) Principles of high altitude aerodynamics, performance capabilities and limitations - including high altitude operations, and flight techniques;

(14) Differences in airplane performance (thrust available) during high versus low altitude operations, the effects of those differences on stall recovery, and the anticipated altitude loss during a recovery;

(15) Stall-related accidents, incidents, Aviation Safety Action Program (ASAP), flight operations quality assurance (FOQA), and Aviation Safety Reporting System (ASRS) data for the specific airplane type or class; and

(16) For airplanes equipped with a stick pusher, recommended recovery actions in response to stick pusher activation.

3-3. SIMULATOR TRAINING. Training providers are encouraged to use the highest level FFS available when developing their approach-to-stall training curriculums. The primary emphasis is providing the pilot with the most realistic environment possible during approach-to-stall training/evaluation. Motion in a FFS should be used when a pilot needs to feel the stimulus and develop skill-based recognition and recovery behaviors that rely on motion.

NOTE: Instructors/evaluators must be familiar with the limitations of a particular FSTD and ensure that all pilots undergoing training/testing/checking are aware of these limitations to mitigate negative training.

a. Maneuver-Based Training. This training focuses on the mastery of an individual task or tasks. Maneuver-based training should include prevention and recovery training with an emphasis on the development of required motor skills to satisfactorily accomplish stall recovery. Only limited emphasis should be placed on decision-making skills during maneuver-based training.

(1) Maneuvers. Maneuver-based training should include the following tasks:

(a) Takeoff or Maneuvering configuration approach-to-stalls,

(b) Clean configuration approach-to-stalls, and

(c) Landing configuration approach-to-stalls.

(2) Stall Scenarios. The three tasks should be trained using realistic scenarios in the following conditions:

(a) Level flight and turns using a bank angle of 15 to 30 degrees,

(b) Manual and automated (autopilot and/or autothrottle, if installed) flight,

NOTE: While it may be difficult to use autothrottle during maneuver-based training since the autothrottle is usually disconnected and thrust reduced to idle, it is important to teach disconnecting the autopilot and autothrottle during stall recovery and to develop scenarios where the autothrottle is engaged.

(c) Visual and instrument flight conditions,

(d) High and low altitudes, and

(e) Various weight and balance within airplane limitations.

(3) Emphasis Items. The following items should be emphasized during maneuver-based training:

(a) How changes to factors such as weight, G loading, bank angle, altitude and icing affect the handling characteristics and stall speeds of the airplane.

(b) Abrupt pitch up and trim change commonly associated when the autopilot unexpectedly disconnects during a stall event. This dramatic pitch and trim change typically represents an unexpected physical challenge to the pilot when trying to reduce AOA. In some airplanes, this may be exacerbated by an additional pitch up when the pilot increases thrust during stall recovery.

(c) Stall warnings for the specific airplane.

(d) Reducing AOA is the proper way to recover from a stall event. Pilots must accept that reducing the airplane's AOA may often result in altitude loss. The amount of altitude loss will be affected by the airplane's operational environment (e.g., entry altitude, airplane weight, density altitude, bank angle, airplane configuration, etc.). At high altitudes, stall recovery may require thousands of feet.

(e) Noises associated with stick shakers and autopilot disconnect alarms can cause confusion in the cockpit.

(f) Understanding that early recognition and return of the airplane to a controlled and safe state are the most important factors in surviving stall events (only after recovering to a safe maneuvering speed and AOA should the pilot focus on establishing an assigned heading, altitude, and airspeed).

(g) Differences between high and low altitude stalls; pitch rate and sensitivity of flight controls, thrust available for recovery, and altitude loss.

(h) The effects of malfunctioning and/or deferred equipment on stall protection and stick pusher systems.

b. Stick Pusher Training. For airplanes equipped with a stick pusher, pilots should accomplish academic training and practical training in an FFS. It is important for pilots to experience the sudden forward movement of the control wheel during a stick pusher activation. From observations, most instructors state that, regardless of previous academic training, pilots (on their first encounter with a stick pusher) usually resist the stick pusher and immediately pull back on the control wheel rather than releasing pressure as they have been taught. Therefore, pilots should receive practical stick pusher training in a FFS in order to develop the proper response (allowing the pusher to reduce AOA) when confronted with a stick pusher activation. Stick pusher training should be completed as a demonstration/practice exercise, including repetitions, until the pilot's reaction is to permit the reduction in AOA even at low altitudes. Deliberate activation of the pusher is not an evaluated maneuver.

c. Scenario-Based Training (SBT). The goal of SBT is to develop decision-making skills relating to stall prevention and recovery during Line-Oriented Flight Training (LOFT). SBT would normally be used during the later stages of an initial type training course and during recurrent training.

(1) Scenarios. When possible, scenarios should include accident, incident, Aviation Safety/ Accident Prevention system (ASAP), FOQA, and/or Aviation Safety Reporting System (ASRS) data to provide realistic opportunities to see how threat situations may develop and how they should be managed during line operations. Sample SBT lesson plans are provided in Appendix 2.

(2) Briefing. Pilots should not normally be briefed that they are receiving SBT. The concept is line-oriented flying, which allows the pilots to recognize and manage the expected or unexpected stall threats as they develop during normal operations.

3-4. OTHER CONSIDERATIONS.

a. Startle. Startle has been a factor in stall incidents and accidents. Although it may be difficult to create the physiological response of startle in the training environment, if achieved, startle events may provide a powerful lesson for the crew. The goal of using startle in training is to provide the crew with a startle experience which allows for the effective recovery of the airplane. Considerable care should be used in startle training to avoid negative learning.

b. Prevention Training. Prevention training provides pilots with the skills to recognize conditions that increase the likelihood of a stall event if not effectively managed. Prevention training must include the operator's standard operating procedures (SOP) and CRM for proper avoidance techniques and threat mitigation strategies. Desired training goals for prevention training should include the following:

(1) Proper recognition of operational and environmental conditions that increase the likelihood of a stall event occurring;

(2) Knowledge of basic stall fundamentals, factors that affect stall speed, stall characteristics for the specific airplane and any implications for the expected flight operations;

(3) Proper aeronautical decision-making skills to avoid stall events (effective analysis, awareness, resource management, mitigation strategies, and breaking the error chain through airmanship and sound judgment);

(4) Proper recognition of signs of an impending stall so pilots can recognize conditions that can lead to a stall event;

(5) The effects of autoflight and unexpected disconnects of the autopilot and/or autothrottle; and

(6) Proper recognition of when the flight condition has transitioned from the prevention phase and into the recovery phase.

CHAPTER 4. STALL RECOVERY TEMPLATE

4-1. AIRPLANE COMMONALITIES. Airplane manufacturers (Airbus, ATR, Boeing, Bombardier and Embraer) created a stall recovery template that provides commonality among various airplanes that could be used by current and future airplane manufacturers to develop airplane-specific stall recovery procedures. For operators of airplanes for which the manufacturer does not publish a stall recovery procedure, the FAA recommends the stall recovery template's use as a reference when developing operator specific stall recovery procedures.

4-2. AIRPLANE DIFFERENCES. The basic steps were identifying airplane differences (stick pushers, stick shakers, turbojets versus turboprops, wing-mounted engines, tail-mounted engines, fly-by-wire and non-fly-by-wire, etc.), finding the commonalities, and proceeding to find a simple, easily understandable stall recovery template. In addition to presenting the recovery steps, the template also provides the rationale for each step of the procedure to enable manufacturers to better determine the applicability to their specific airplane.

4-3. STALL RECOVERY TEMPLATE. The stall recovery template for manufacturers is provided in Table 1, Stall Recovery Template (with Associated Rationale). Although the procedures should apply to the majority of today's airplanes, manufacturer-recommended procedures may deviate from those included in this AC due to specific airplane characteristics. Specific items, such as configuration changes (i.e., flaps extension), that could be required at a specific point during the recovery procedure are not included in the template, but will be included in a specific procedure for a particular airplane. Manufacturers are expected to deviate from this template if the airplane operating characteristics require.

> **NOTE: Operators should work with their airplane manufacturer(s) to ensure they have the manufacturer-approved, airplane-specific stall recovery procedure in their operating manual.**

> **NOTE: The manufacturer's procedures take precedence over the recommendations in this AC.**

TABLE 1. STALL RECOVERY TEMPLATE (WITH ASSOCIATED RATIONALE)

1	**Autopilot and autothrottle……………………………….Disconnect**
Rationale	While maintaining the attitude of the airplane, disconnect the autopilot and autothrottle. Ensure the pitch attitude does not increase when disconnecting the autopilot. This may be very important in out-of-trim situations. Manual control is essential to recovery in all situations. Leaving the autopilot or autothrottle connected may result in inadvertent changes or adjustments that may not be easily recognized or appropriate, especially during high workload situations.
2	**a) Nose down pitch control… Apply until stall warning is eliminated** **b) Nose down pitch trim…….…………………………..….As Needed**
Rationale	a) Reducing the angle of attack is crucial for recovery. This will also address autopilot-induced excessive nose up trim. b) If the control column does not provide sufficient response, pitch trim may be necessary. However, excessive use of pitch trim may aggravate the condition, or may result in loss of control or high structural loads.
3	**Bank……………………………………………………..…….Wings Level**
Rationale	This orients the lift vector for recovery.
4	**Thrust ……………………………………………….…………As Needed**
Rationale	During a stall recovery, maximum thrust is not always needed. A stall can occur at high thrust or at idle thrust. Therefore, the thrust is to be adjusted accordingly during the recovery. For airplanes with engines installed below the wing, applying maximum thrust may create a strong nose-up pitching moment if airspeed is low. For airplanes with engines mounted above the wings, thrust application creates a helpful pitch-down tendency. For propeller-driven airplanes, thrust application increases the airflow around the wing, assisting in stall recovery.
5	**Speed brakes/Spoilers……….…….……………………………..Retract**
Rationale	This will improve lift and stall margin.
6	**Return to the desired flightpath.**
Rationale	Apply gentle action for recovery to avoid secondary stalls then return to desired flightpath.

APPENDIX 1. SAMPLE DEMONSTRATIONS

1. Two demonstrations were constructed using the philosophies and concepts described in this AC. The first is an approach-to-stall recovery with only idle thrust available that emphasizes the need to reduce the angle of attack (AOA) to recover from a stall. The second is a stick pusher demonstration (if equipped).

2. Training providers are encouraged to develop additional demonstrations to fit their training needs. The examples should be easily tailored to any transport category airplane. The examples given are not intended to be limiting in any way. They are simply provided as a framework for development of a training curriculum.

> **NOTE: The manufacturer's procedures take precedence over the recommendations in this AC.**

EXAMPLES OF "DEMONSTRATION FOR STALL TRAINING"

DEMONSTRATION 1	Approach-to-stall recovery with only idle thrust available.
PURPOSE	This *demonstration* is only intended to show that the airplane will return to controlled flight by simply reducing the AOA. It does not show the pilot the complete procedure for recovering from an aerodynamic stall or approach-to-stall.
OBJECTIVE	The pilot will recover from an approach-to-stall by reducing the AOA without applying thrust.
EMPHASIS AREAS	• Crew coordination, and • AOA management.
FSTD SETUP CONSIDERATIONS	This demonstration may be completed in any airplane configuration or any altitude that allows a recovery.
DEMONSTRATION ELEMENTS	• At level flight, reduce thrust to idle. • Increase AOA to achieve the first indication of a stall without regard to holding altitude. • Upon the first indication of a stall, direct the crew to recover solely by lowering the nose to reduce the AOA. • The demonstration is performed with only idle thrust.
COMPLETION STANDARDS	• The instructor will advise the student that the maneuver is complete when the student understands the need to reduce AOA for stall recovery.

DEMONSTRATION 2	Stick Pusher Demonstration (if installed)
PURPOSE	The pilot understands that stick pusher activation is a stall event safety device that must be relied upon and not overridden. The stick pusher is an automated control input when the airplane approaches the critical AOA. If not resolved, the condition that activated the stick pusher will lead to a full aerodynamic stall and possible loss of control. The pilot should be able to perform the appropriate actions should a stick pusher activation occur.
OBJECTIVE	The pilot will allow the stick pusher to reduce the AOA to prevent an aerodynamic stall and then perform the correct recovery procedure without resisting the stick pusher.
EMPHASIS AREAS	• Recognition. • Crew coordination. • AOA management: Allow the pusher to reduce the AOA and observe its effectiveness in preventing the aerodynamic stall (may be accomplished with or without additional thrust). • Audible and visual warnings (environment and airplane cueing). • Effects of altitude on recovery. • To avoid possible negative training, the instructor should inform the student all approach-to-stall indications leading up to the pusher must be disregarded in order for the pusher activation to occur. This is a good opportunity to demonstrate and re-emphasize all approach-to-stall cues. • Crewmember understanding for airplanes equipped with a stick pusher, recommended recovery actions in response to stick pusher activation, including activation when in close proximity to the ground or at cruise altitude.
FSTD SET-UP CONSIDERATIONS	This demonstration may be completed in any airplane configuration or any altitude that allows for a recovery.
DEMONSTRATION ELEMENTS	• In level flight, reduce thrust to idle. • AOA should be increased to achieve the activation of the stick pusher. • Review approach-to-stall indications as they occur. • Upon stick pusher activation, direct the crew to allow the pusher activation and then initiate recovery procedure.
COMPLETION STANDARDS	• The pilot releases back-pressure at pusher activation and allows it to reduce the AOA.

	• Recovers to the maneuvering speed appropriate for the airplane's configuration without exceeding the airplane's limitations. It is probable that some loss of altitude will occur during the recovery. • The maneuver is considered complete once a safe speed is achieved and the airplane stabilized in level flight.

APPENDIX 2. SAMPLE TRAINING SCENARIOS

Three scenarios were constructed using the philosophies and concepts described in this AC. They include clean configuration (high altitude), takeoff, and landing configuration approach-to-stalls. Training providers are encouraged to develop additional scenarios that fit their training needs. The examples should be easily tailored to any transport category airplane. The examples given are not intended to be limiting in any way, they are provided as a framework for developing a training curriculum.

NOTE: The manufacturer's procedures take precedence over the recommendations in this AC.

EXAMPLES OF SCENARIOS FOR STALL TRAINING

SCENARIO 1: CLEAN CONFIGURATION APPROACH-TO-STALL (HIGH ALTITUDE)	
INSTRUCTOR ROLE	Implement scenarios that result in an unexpected approach-to-stall near the airplane's maximum operating altitude.
OBJECTIVE	The pilot will recognize the stall warning and immediately perform the stall recovery procedure. The pilot should demonstrate willingness to trade altitude for airspeed to accomplish an expeditious recovery from a stall event.
EMPHASIS AREAS	• Recognition and recovery. • Crew coordination. • AOA management. • Out of trim control forces at autopilot disconnection. • Aural and visual warnings (environment and airplane cuing). • Surprise and startle. • Roll instability and buffeting. • Effects of multiple levels of automation. • Effects of altitude on recovery. • There is no predetermined value for altitude loss and maintaining altitude during recovery is not required. • Airway/oceanic tracks and Reduced Vertical Separation Minimum (RVSM) considerations • Situational awareness (SA) while returning to desired flightpath after the stall recovery, including such items as heading, altitude, other aircraft, and flight deck automation.
FSTD SETUP CONSIDERATIONS	This scenario will be conducted near maximum operating altitude for the specific airplane weight and

	temperature. Crew distractions may be used (e.g., minor malfunctions, air traffic control (ATC) instructions, weather). Use of simulator capabilities to induce approach-to-stalls may include: • Airspeed slewing. • Attitude changes. • Airplane weight and center of gravity (CG) changes. • Environmental changes. • Systems malfunctions (e.g., full or partial pitot/static blockage, artificial thrust reduction, surreptitious disabling of automation).
SCENARIO ELEMENTS	• At level flight with the autopilot on, introduce an event or reduce thrust to less than adequate for maneuvering flight. • Upon recognizing the first indication of a stall, perform the stall recovery procedure. • The necessity for smooth, deliberate, and positive control inputs to avoid increasing load factors and secondary stalls. • During recovery, if the pilot is aggressive and increases load factor too early, approach-to-stall cues should be recognized and appropriate action taken to decrease load factors to avoid stick pusher activation (if installed). If stick pusher activates, it must be allowed to act and then appropriate recovery action should be taken.
COMPLETION STANDARDS	• The pilot will perform a deliberate and smooth reduction of AOA. • Positive recovery from the stall event takes precedence over considerations of altitude loss. • Appropriate application of thrust to accelerate and enable an expeditious recovery. • The return of the airplane to safe flight without encountering a secondary stall. • The maneuver is considered complete once a safe speed is achieved and the airplane stabilized. • Satisfactory crew coordination must be demonstrated.
COMMON STUDENT ERRORS	• Recovery is attempted with thrust instead of reducing AOA. • Under/over control of pitch inputs. • Student fails to recognize impending secondary

	stall. • Reluctance to sacrifice significant altitude. • Student fails to distinguish between high speed and low speed stall. • Student increases the load factor too quickly and gets secondary approach-to-stall cues or stick pusher activation.

SCENARIO 2: TAKEOFF APPROACH-TO-STALL WITH PARTIAL FLAPS	
INSTRUCTOR ROLE	Implement scenarios that result in an unexpected approach-to-stall on departure prior to flaps being fully retracted.
OBJECTIVE	The pilot will recognize the stall warning and immediately perform the stall recovery procedure, then resume the assigned departure.
EMPHASIS AREAS	• Recognition and recovery. • Crew coordination. • AOA management. • Out-of-trim control forces at autopilot disconnect (if engaged). • Aural and visual warnings (environment and airplane cueing). • Surprise and startle. • Roll instability and buffeting. • Effects of multiple levels of automation. • Effects of altitude on recovery. • SA while returning to desired flightpath after the stall recovery, including such items as heading, terrain, altitude, other aircraft, and flight deck automation. • There is no predetermined value for altitude loss, and maintaining altitude during recovery is not required.
FSTD SETUP CONSIDERATIONS	The scenario will be conducted during takeoff and/or departure, at an altitude that will allow for a recovery. Crew distractions may be used (e.g., minor malfunctions, air traffic controller instructions, weather). Use of simulator capabilities to induce approach-to-stalls may include: • Airspeed slewing, • Attitude changes, • Airplane weight and CG changes, • Environmental changes, and • Systems malfunctions (e.g., full or partial pitot/static blockage, artificial thrust

	reduction, surreptitious disabling of automation).
SCENARIO ELEMENTS	• During departure, reduce thrust to less than adequate to maintain airspeed and climb rate. • Upon recognizing the first indication of a stall, perform the stall recovery procedure. • During recovery, the pilot should not allow the airplane to reach the AOA for the stick pusher to activate. If the stick pusher activates, it must be allowed to act and then appropriate recovery action should be taken by the pilot. • When recovery is assured, adjust the pitch attitude to initiate a climb to the assigned departure altitude.
COMPLETION STANDARDS	• The pilot will perform a deliberate and smooth reduction of AOA. • Positive recovery from the stall event takes precedence over minimizing altitude loss. • Appropriate application of thrust to accelerate and enable an expeditious recovery. • The return of the airplane to safe flight without encountering a secondary stall. • The maneuver is considered complete once the flight reaches and stabilizes at the assigned departure altitude. • Satisfactory crew coordination must be demonstrated.
COMMON STUDENT ERRORS	• Recovery is attempted with no loss of altitude. • Recovery is attempted without recognizing the importance of pitch control and AOA. • Rolling wings level prior to AOA reduction. • Failure to roll wings level to improve performance. • Losing SA and failing to return to assigned flightpath or follow ATC instructions after recovery.

SCENARIO 3: LANDING CONFIGURATION STALL	
INSTRUCTOR ROLE	Implement scenarios that result in an unexpected approach-to-stall during an approach.
OBJECTIVE	The pilot will recognize the stall warning and immediately perform the stall recovery procedure, then commence missed approach.
EMPHASIS AREAS	• Recognition and recovery. • Crew coordination. • AOA management. • Out-of-trim control forces at autopilot disconnect (if engaged). • Aural and visual warnings (environment and airplane cueing). • Surprise and startle. • Roll instability and buffeting. • Effects of multiple levels of automation. • Effects of altitude on recovery. • SA while returning to desired flightpath after the stall recovery, including such items as heading, terrain, altitude, other aircraft, and flight deck automation. • There is no predetermined value for altitude loss and maintaining altitude during recovery is not required.
FSTD SETUP CONSIDERATIONS	The scenario will be conducted during approach to landing in the landing configuration, at an altitude that will allow for a recovery. Crew distractions may be used (e.g., minor malfunctions, ATC instructions, weather). Use of simulator capabilities to induce approach-to-stalls may include: • Airspeed slewing, • Attitude changes, • Airplane weight and CG changes, • Environmental changes, and • System malfunctions (e.g., full or partial pitot/static blockage, artificial thrust reduction, surreptitious disabling of automation).
SCENARIO ELEMENTS	• At 1,000 feet above ground level (AGL), reduce thrust to be inadequate to maintain a safe speed or descent angle, and results in an increase in AOA to maintain glidepath. • Upon the first indication of a stall, perform the stall recovery procedure • During recovery, the pilot should not allow the airplane to reach the AOA for the stick pusher

	to activate. If the stick pusher activates, it must be allowed to activate and then the pilot should than take appropriate recovery action. • When recovery is assured, adjust the pitch attitude to initiate a climb to comply with missed approach instructions.
COMPLETION STANDARDS	• The pilot will perform a deliberate and smooth reduction of AOA. • Positive recovery from the aerodynamic stall or approach-to-stall takes precedence over minimizing attitude loss. • Appropriate application of thrust to accelerate and enable an expeditious recovery. • The return of the airplane to safe flight without encountering a secondary stall. • The maneuver is considered complete when safe speed has been achieved and the pilot initiates the missed approach. • Satisfactory crew coordination must be demonstrated.
COMMON STUDENT ERRORS	• Recovery is attempted with no loss of altitude. • Recovery is attempted without recognizing the importance of pitch control and AOA. • Rolling wings level prior AOA reduction. • Failure to roll wings level to improve performance. • Losing SA and failing to return to assigned flightpath and complete a missed approach, or follow ATC instructions after recovery.

APPENDIX 3. FSTD CONSIDERATIONS

1. SUMMARY OF SIMULATOR CAPABILITIES. FSTDs which replicate transport category airplanes and are appropriately qualified by the FAA, as of 2011, can be reliably used for training to the first indication of a stall, which includes angles of attack up to the stall warning.

a. High-Altitude Stalls or Stalls with Moderate Bank Angles. If approach-to-stall training includes high-altitude stalls or stalls with moderate bank angles that significantly differ from objectively validated flight conditions, training providers should conduct additional testing to ensure adequate fidelity in these training maneuvers (such as verification of stall warning speeds, stall buffet speeds, etc.).

b. Stick Pusher Demonstrations. Full Flight Simulators (FFS) may be used beyond the first indication of stall for demonstrations of the stick pusher (if installed); however, training providers should conduct additional testing to ensure that the FFS's stick pusher force complies with the design requirements specified by the manufacturer to ensure that it accurately represents the airplane. Training providers desiring to conduct stick pusher demonstrations as part of an FAA-approved flight training program are encouraged to contact the National Simulator Program (NSP) for additional guidance in evaluating an FSTD for such maneuvers.

c. Aerodynamic Stall and Post-Stall Training. For training to, or past, aerodynamic stall, additional testing and validation of the specific FSTD may be necessary because of the variations among FSTDs. While some FSTDs may have the fidelity allowing training past the approach-to-stall condition, the potential of negative training exists if simulated flight in this regime is not properly evaluated (through objective testing and evaluation by an SME pilot experienced in the stall characteristics of the airplane). The FAA does not recommend post-stall training unless the FSTD is properly evaluated, because the roll and yaw characteristics of the FSTD may not be representative of the airplane. Training providers desiring to conduct full stall training as part of an FAA-approved flight training program are encouraged to contact the NSP for additional guidance in evaluating an FSTD for such maneuvers.

2. BACKGROUND INFORMATION. Currently, FSTD qualification standards are defined in 14 CFR part 60. Prior to part 60, FSTD qualification standards were defined in a series of ACs. During the development of this AC, current and historical FSTD qualification standards were examined to determine if adequate evaluation requirements were in place to conduct approach-to-stall and full stall training tasks in currently qualified FSTDs. It was determined that previously qualified FSTDs may not be capable of conducting training tasks to a full aerodynamic stall. The primary factors for this determination are as follows:

- To date, flight training requirements are limited to approach-to-stall maneuvers as opposed to full stall maneuvers. As a result, most current FSTD stall training does not extend to angles of attack much higher than that required to trigger the stall warning system.
- While much of the development of an FSTD's aerodynamic model prior to a full aerodynamic stall can assume a certain extent of linearity in extrapolating performance

and handling characteristics, this assumption is not valid at, or past, full aerodynamic stall where the aircraft dynamics are often unstable.

- To fully evaluate the non-linear characteristics of a stall model, more test points in the form of objective or subjective tests are necessary to validate such models.

a. Stall Model Areas of Concern. Through the efforts of various working groups, several characteristics of a typical FSTD's stall model have been identified as areas of concern where potential negative training could occur due to a low fidelity representation of an aircraft's performance and handling characteristics:

- Lateral and directional handling characteristics;
- Stall buffet characteristics and onset speed;
- Stall hysteresis; and
- Stall handling characteristics in cruise and turning flight conditions.

b. Other Complications. This determination was primarily based upon the lack of required objective testing tolerances and flight conditions needed to fully assess the non-linear behavior of a stall model. Further complicating matters is the relatively small pool of experienced subject matter expert pilots who are qualified to evaluate the aircraft specific characteristics of such a maneuver.

3. FSTD EVALUATION RECOMMENDATIONS. While changes to the FSTD qualification standards are currently being developed, they are outside the scope of this advisory circular. It is highly recommended that all FSTDs being used for approach-to-stall training maneuvers are specifically evaluated for such maneuvers. Based upon existing and past qualification standards, a high level of confidence exists that current appropriately qualified FSTDs can provide an adequate level of fidelity in approach-to-stall training tasks that do not go beyond angles of attack associated with stall warning system activation. The following general evaluation guidelines are provided to assess an FSTD's suitability for use in high angle of attack (AOA) training maneuvers:

a. Approach-to-Stall Training Maneuvers.

(1) To ensure a high level of FSTD fidelity, training maneuvers should be conducted in conditions similar to objectively evaluated test conditions where possible (e.g., aircraft weight, environmental conditions, stall entry rates, etc.). Current objective test requirements are for second-segment climb and approach/landing conditions. The FSTDs Master Qualification Test Guide (MQTG) should be reviewed to assist in determining maneuvers that are likely to have a high level of fidelity.

(2) For approach-to-stall training maneuvers that are not objectively evaluated for FSTD qualification (such as cruise/high altitude approaches to stall and turning flight approaches to stall), the FSTD sponsor should conduct additional objective and subjective evaluation to determine adequate FSTD fidelity. This additional evaluation should include:

(a) Objective evaluation of stall warning and stall buffet speed against published aircraft data (such as AFM stall tables).

(b) Subjective evaluation by a SME pilot that is experienced in the approach to stall characteristics of the aircraft.

b. Stick Pusher Demonstration Maneuvers.

(1) The stick pusher activation speeds (or associated angles of attack) should be objectively evaluated against published aircraft data (such as the AFM stall tables).

(2) The modeling of the stick pusher system or stall protection system should be based upon aircraft Original Equipment Manufacturer (OEM) provided simulation data or other suitable data to ensure correct activation speeds/angles of attack and cancellation logic.

(3) The simulated stick pusher control forces and displacements should be validated against aircraft collected or OEM provided validation data to ensure the FSTD provides the correct control loading force cues.

(4) Since a stick pusher demonstration maneuver will typically occur at angles of attack beyond the activation of the stall warning system, the FSTD's should be evaluated for satisfactory performance and handling qualities by an appropriately qualified Subject Matter Expert (SME) pilot.