



**U.S. Department
of Transportation**
**Federal Aviation
Administration**

Advisory Circular

Subject: Stall Prevention and Recovery
Training

Date: 1/4/17

AC No: 120-109A

Initiated by: AFS-200

Change: 1

1. PURPOSE. This advisory circular (AC) provides best practices on training, testing, and checking of impending stalls and training of full stalls, including recommended recovery procedures.

2. PRINCIPAL CHANGES. This change updates flight simulation training device (FSTD) qualification information for full stall prevention and recovery training tasks in Appendix 5 consistent with the amendments to Title 14 of the Code of Federal Regulations (14 CFR) part 60 in the Flight Simulation Training Device Qualification Standards for Extended Envelope and Adverse Weather Event Training Tasks final rule and updates references in Chapters 1 and 3. This change is also responsive to the FAA Extension, Safety, and Security Act of 2016, section 2102, item 4, which requires the FAA to issue guidance to air carriers by January 11, 2017, regarding standards for compliance with the requirements for enhanced pilot training contained in the Qualification, Service, and Use of Crewmembers and Aircraft Dispatchers final rule published on November 12, 2013.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
Pages iii and iv	11/24/15	Pages iii and iv	1/4/17
Pages 3, 4, 9, 13, 17 (and 18)	11/24/15	Pages 3, 4, 9, 13, 17 (and 18)	1/4/17
Appendix 5, Pages 1 thru 3 (and 4)	11/24/15	Appendix 5, Pages 1 thru 3 (and 4)	1/4/17

John S. Duncan
Director, Flight Standards Service



Advisory Circular

Subject: Stall Prevention and Recovery Training

Date: 11/24/15

AC No: 120-109A

Initiated by: AFS-200

Change:

This advisory circular (AC) provides guidance for training, testing, and checking pilots to ensure correct responses to impending and full stalls. For air carriers, Title 14 of the Code of Federal Regulations (14 CFR) part 121 contains the applicable regulatory requirements. Although this AC is directed to part 121 air carriers, the Federal Aviation Administration (FAA) encourages all air carriers, airplane operators, pilot schools, and training centers to use this guidance for stall prevention training, testing, and checking. This guidance was created for operators of transport category airplanes; however, many of the principles apply to all airplanes. The content 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 includes the following core principles:

- Reducing angle of attack (AOA) is the most important pilot action in recovering from an impending or full stall.
- Pilot training should emphasize teaching the same recovery technique for impending stalls and full stalls.
- Evaluation criteria for a recovery from an impending stall should not include a predetermined value for altitude loss. Instead, criteria should consider the multitude of external and internal variables that affect the recovery altitude.
- Once the stall recovery procedure is mastered by maneuver-based training, stall prevention training should include realistic scenarios that could be encountered in operational conditions, including impending stalls with the autopilot engaged at high altitudes.
- Full stall training is an instructor-guided, hands-on experience of applying the stall recovery procedure and will allow the pilot to experience the associated flight dynamics from stall onset through the recovery.

This revision of AC 120-109 reflects new part 121 regulatory terms and incorporates the full stall training requirement of Public Law 111-216. Considerable evaluation of the full flight simulator (FFS) must occur before conducting full stall training in simulation. Reference Appendix 5 for FFS evaluation considerations.

CONTENTS

	Page
Paragraph	Page
CHAPTER 1. BACKGROUND INFORMATION	1
1-1. General.....	1
1-2. Cancellation	1
1-3. Summary of Changes.....	1
1-4. Air Carriers Conducting Training in Airplanes	1
1-5. Part 121 Requirements	2
1-6. Advanced Qualification Programs.....	2
1-7. Definitions/Terms	2
1-8. Related Regulations	4
1-9. Related FAA Guidance (current editions)	4
1-10. Related References	4
1-11. AC Feedback Form.....	4
CHAPTER 2. STALL TRAINING CURRICULUMS	5
2-1. General.....	5
2-2. Training Goals.....	5
2-3. Training Requirements (§§ 121.418, 121.419, 121.423, 121.424, and 121.427)	6
2-4. Instructor/Evaluator Standardization (§§ 121.413 and 121.414).....	6
2-5. Recovery Procedures	7
2-6. Flight Standardization Board (FSB) Reports.....	7
CHAPTER 3. GROUND/ACADEMIC TRAINING	9
3-1. Academic Knowledge.....	9
3-2. Knowledge Areas.....	9
CHAPTER 4. STALL PREVENTION TRAINING AND CHECKING	13
4-1. General.....	13
4-2. Simulator Training (§ 121.424)	13
4-3. Using Surprise in Training.....	16
4-4. Checking Parameters	16
4-5. Checking Criteria.....	16
4-6. Realistic Settings for Checking.....	16
4-7. Debriefing	17
CHAPTER 5. STALL RECOVERY TRAINING	19
5-1. General.....	19
5-2. Full Stall Training	19
5-3. Full Stall Training Maneuver.....	19
5-4. Stick Pusher	19

CONTENTS (Continued)

Paragraph	Page
APPENDIX 1. STALL RECOVERY TEMPLATE (2 pages).....	1
APPENDIX 2. SAMPLE DEMONSTRATIONS (2 pages)	1
APPENDIX 3. SAMPLE TRAINING SCENARIOS (6 pages)	1
APPENDIX 4. SAMPLE FULL STALL TRAINING MANEUVER (2 pages)	1
 APPENDIX 5. FULL FLIGHT SIMULATOR CONSIDERATIONS (4 pages).....	1

CHAPTER 1. BACKGROUND INFORMATION

1-1. GENERAL. Based on accident review, a concern exists within the Federal Aviation Administration (FAA) and industry regarding loss of control in-flight (LOC-I) accidents and incidents. A recurring causal factor in LOC-I accidents and incidents is the pilot's inappropriate reaction to impending stalls and full stalls. Evidence exists that some pilots are failing to avoid conditions that may lead to a stall, or are failing to recognize the insidious onset of an impending 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. Stall training should always emphasize reduction of angle of attack (AOA) as the most important response when confronted with an impending or full stall. This advisory circular (AC) provides best practices on training, testing, and checking of impending stalls and training of full stalls, including recommended recovery procedures.

1-2. CANCELLATION. AC 120-109, Stall and Stick Pusher Training, dated August 6, 2012, is canceled.

1-3. SUMMARY OF CHANGES. Many minor changes have been made to improve clarity, accuracy, completeness, and consistency. Significant changes include the following:

- Additional information to support the requirement for stall recovery training.
- Added regulatory requirements contained in the Qualification, Service, and Use of Crewmembers and Aircraft Dispatchers final rule issued November 12, 2013, and associated supporting information.
- Updated information in Appendix 5, Full Flight Simulator Considerations.
- Updated and/or added the following definitions: stall prevention training, stall recovery training, full stall, stall warning, and secondary stall warning.

1-4. AIR CARRIERS CONDUCTING TRAINING IN AIRPLANES.

a. Stall Prevention Training. Although the training in this AC is designed to be conducted in a flight simulation training device (FSTD), those operators using airplanes for training can incorporate into their training programs all of the academic elements and some of the flight training elements. Operators should carefully select flight training maneuvers and employ risk mitigation strategies. Airplanes used for flight training elements should be those designed for the specific maneuvers being conducted, and training programs should use instructors specifically qualified to conduct stall training in airplanes. The FAA recommends that any operator conducting stall training in airplanes follow the guidance and associated risk mitigation strategies contained in ICAO's Doc 10011, Manual on Aeroplane Upset Prevention and Recovery Training.

b. Stall Recovery Training. For Title 14 of the Code of Federal Regulations (14 CFR) part 121 air carriers, § 121.423(c) requires an instructor-guided, hands-on experience of recovery from full stall and stick pusher activation, if equipped, to be conducted in a Level C or higher full flight simulator (FFS). Air carriers are encouraged to use the highest fidelity level FFS available. In accordance with § 121.423, part 121 air carriers may submit a request to the Administrator for

approval of a deviation from the FFS requirements to conduct the extended envelope training using an alternative method to meet the learning objectives of § 121.423.

1-5. PART 121 REQUIREMENTS (§ 121.423(c) and Part 121 Appendices E and F). All part 121 air carriers, including those who train under an Advanced Qualification Program (AQP), are required to conduct stall prevention training, and beginning March 12, 2019, all part 121 air carriers must conduct instructor-guided, hands-on experience of recovery from full stall and stick pusher activation, if equipped. The requirement for part 121 pilots to receive stall recovery training is statutorily mandated in Public Law 111-216, Section 208. The FAA does not have the authority to exempt any part 121 air carrier from this requirement.

1-6. ADVANCED QUALIFICATION PROGRAMS. For simplicity, because part 121 subpart N and appendices E and F contain the requirements for stall prevention and recovery training, the terminology used in this AC is consistent with those regulations. Therefore, the term checking is used and the terms for the training categories defined in § 121.400 are used. Air carriers with an AQP should make terminology adjustments, as appropriate. Regardless of the type of training program, the instructor-guided, hands-on experience of recovery from full stall and stick pusher activation, if equipped, is a training maneuver that is not checked or evaluated. Air carriers with an AQP should use this AC in conjunction with the current edition of AC 120-54, Advanced Qualification Program.

1-7. DEFINITIONS/TERMS. To provide greater clarity for the training community, stall terminology in this AC has been simplified. For the purpose of this AC, the following definitions and terms are provided:

- a. Angle of Attack (AOA).** The angle between the oncoming air, or relative wind, and a reference line on the airplane or wing.
- b. Crew Resource Management (CRM).** Effective use of all available resources: human resources, hardware, and information.
- c. Flight Simulation Training Device (FSTD).** An FFS or a flight training device (FTD).
- d. Full Stall.** Any one, or combination of, the following characteristics: (a) an uncommanded nose-down pitch that cannot be readily arrested, which may be accompanied by an uncommanded rolling motion; (b) buffeting of a magnitude and severity that is a strong and effective deterrent to further increase in AOA; (c) no further increase in pitch occurs when the pitch control is held at the full aft stop for 2 seconds, leading to an inability to arrest descent rate; (d) activation of a stick pusher.
- e. Impending Stall.** An AOA that causes a stall warning. In this AC, impending stall means the same as the AOA for an approach-to-stall or the first indication of stall.
- f. Landing Configuration.** Landing gear extended and the flaps set at an approved setting for a normal landing.
- g. Maneuver-Based Training.** Training that focuses on a single event or maneuver in isolation.

- h. Scenario-Based Training (SBT).** Training that incorporates maneuvers into real-world experiences to cultivate practical flying skills in an operational environment.
 - i. Secondary Stall.** A premature increase in AOA that results in another full stall during stall recovery, prior to a stable flight condition being established.
 - j. Secondary Stall Warning.** A reoccurrence of a stall warning.
 - k. Stall Event.** An impending stall or a full stall.
 - l. Stall Prevention Training.** Ground and flight instruction to recognize and to avert an impending stall, and to reinforce the application of the stall recovery procedure for an impending or full stall.
 - m. Stall Recovery Procedure.** The correct, airplane-specific actions developed by the operator, in consultation with their airplane manufacturer, that their pilots apply to return the airplane to safe flight after a stall. If consultation is impracticable, the stall recovery template in Appendix 1 can be used.
 - n. Stall Recovery Training.** Instructor-guided, hands-on experience of applying the stall recovery procedure for a full stall.
 - o. Stall Warning.** An alert furnished either through inherent aerodynamics, such as buffeting, or by synthetic means, such as a stick shaker or a persistent aural-and-visual cue, giving clear indications prior to a full stall to allow a pilot to prevent a full stall. Refer to 14 CFR part 25, § 25.207.
 - p. Startle.** An uncontrollable, automatic muscle reflex, raised heart rate, blood pressure, etc., elicited by exposure to a sudden, intense event that violates a pilot's expectations.
 - q. Stick Pusher.** A safety system that applies downward elevator pressure to assist in the avoidance, identification, or recovery of a full stall.
 - r. Surprise.** An unexpected event that violates a pilot's expectations and can affect the mental processes used to respond to the event.
 - s. 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.
 - t. Transfer of Training.** The degree to which what was learned in training (e.g., classroom FSTD) can be applied on-the-job (e.g., flight operations). In this context, “negative transfer of training” is when knowledge or skills learned in the classroom or FSTD impede the knowledge or skills necessary to operate an aircraft in flight.
 - u. Uncoordinated Flight.** Flight with slipping or skidding.

v. **Undesired Aircraft State.** A condition that unacceptably reduces safety margins, including low energy situations.

1-8. RELATED REGULATIONS. Title 14 CFR parts 25, 61, 91 subpart K (part 91K), 121, 125, 135, 141, and 142.

1-9. RELATED FAA GUIDANCE (current editions):

- Safety Alert for Operators (SAFO) 10012, Possible Misinterpretation of the Practical Test Standards (PTS) Language “Minimal Loss of Altitude.”
- Information 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 and Air Agency Certification and Application Process.
- Order 8900.1, Volume 3, General Technical Administration.
- Order 8900.1, Volume 5, Airman Certification.
- AC 120-51, Crew Resource Management Training.
- AC 120-54, Advanced Qualification Program.
- AC 120-90, Line Operations Safety Audits.
- AC 120-111, Upset Prevention and Recovery Training.
- AC 120-114, Pilot Training and Checking (14 CFR Part 121 Subparts N and O, Including Appendices E and F).

1-10. RELATED REFERENCES:

- Airplane Upset Recovery Training Aid (AURTA) Revision 2:
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 – The LOSA Collaborative): <http://www.skybrary.aero/bookshelf/books/1982.pdf>.
- An Evaluation of Several Stall Models for Commercial Transport Training, J. Schroeder, J. Burki-Cohen, D. Shikany, D. Gingras, and P. Desrochers, AIAA Modeling and Simulation Technologies Conference, National Harbor, MD, Jan. 2014: http://www.faa.gov/pilots/training/media/Evaluation_of_Stall_Models_for_Training.pdf.

1-11. AC FEEDBACK FORM. For your convenience, the AC Feedback Form is the last page of this AC. Note any deficiencies found, clarifications needed, or suggested improvements regarding the contents of this AC on the Feedback Form.

CHAPTER 2. STALL TRAINING CURRICULUMS

2-1. GENERAL.

a. Common Guidance. This chapter provides common guidance for all stall prevention and recovery training curriculums, while Chapters 4 and 5 provide detailed information for stall prevention training and checking and stall recovery training, respectively. 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. The reason for using the term “stall event” is to emphasize that the recovery technique for an impending stall or full stall is the same.

b. Stall Event Training. Stall event training must include both ground and flight training. The training methodology should follow the building block approach of first introducing essential concepts and academic understanding during ground training before progressing to the practical application of those skills in an FFS. 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 leads to a more complete appreciation of how to recognize an impending stall, respond appropriately in situations of surprise, and recover effectively when required. Training providers should develop training curriculums that provide pilots with the knowledge and skills to recognize, prevent, and recover from unexpected stall events. These training curriculums should contain the elements described in this AC.

c. Envelope-Protected Airplanes. Envelope-protected airplanes have, in general, demonstrated a lower rate of stall accidents and incidents; however, the rate is not zero. Stall accidents and incidents in envelope-protected airplanes typically occur when the protections have failed, requiring the pilot to return the aircraft to safe flight using a degraded flight control mode. As such, it is important to carefully develop the stall prevention and recovery training for envelope-protected aircraft so that (1) the failure path(s) to reach the degraded modes are understood, (2) pilots learn to identify the rarely occurring impending or full stalls, and (3) pilots demonstrate they have the skill to return the aircraft to safe flight with the degraded flight control laws. Although the potential failures that lead to degraded modes must be understood by pilots, handling multiple failures should not be a component of maneuver-based stall training. The simulator should be placed in a degraded mode by the instructor, clearing all warnings and cautions associated with the failures before the stall training begins. Training providers should seek manufacturer guidance for preferred methods of placing the simulator in degraded modes.

2-2. TRAINING GOALS.

Desired training goals for stall prevention and recovery training include the following:

- a.** Proper recognition of operational and environmental conditions that increase the likelihood of a stall event.
- b.** Knowledge of stall fundamentals, including factors that affect stall speed and any implications for the expected flight operations.
- c.** Understanding of the stall characteristics for the specific airplane.

- d. Proper aeronautical decisionmaking skills to avoid stall events (e.g., effective analysis, awareness, resource management, mitigation strategies, and breaking the error chain through airmanship and sound judgment).
- e. Proper recognition of an impending stall in varied conditions and configurations.
- f. The effects of autoflight, flight envelope protection in normal and degraded modes, and unexpected disconnects of the autopilot or autothrottle/autothrust.
- g. Proper recognition of when the flight condition has transitioned from the prevention phase and into the recovery phase.
- h. Proper application of the stall recovery procedure.

2-3. TRAINING REQUIREMENTS (§§ 121.418, 121.419, 121.423, 121.424, and 121.427).

While basic aerodynamics and stall training are accomplished as part of a pilot's private, commercial, and airline transport pilot (ATP) certifications, it is important to reinforce this basic training throughout a pilot's career. 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 stall event training that a pilot should receive when employed by a part 121 air carrier. The essential concepts of stall training should be standalone training. Once the concepts are mastered, stall training may be incorporated into other training areas (e.g., CRM, adverse weather training, etc.). Air carriers must include stall event training for pilots during:

- Initial training,
- Transition training,
- Differences and related aircraft differences training (if differences exist),
- Upgrade training,
- Requalification training (if applicable), and
- Recurrent training.

2-4. INSTRUCTOR/EVALUATOR STANDARDIZATION (§§ 121.413 and 121.414).

Instructors and evaluators should receive training in the subject areas contained in this AC. Knowledge of these subject areas ensures accurate stall event training and minimizes the risk of negative transfer of training.

- a. **Instructor/Evaluator 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 should:

- Demonstrate knowledge of all subject areas of this advisory circular;
- Demonstrate proficiency in all skill areas of this advisory circular; and
- Demonstrate proficiency in conducting maneuver-based and scenario-based stall prevention and recovery training.

b. Understanding of FFS Limitations. Instructors/evaluators must have a clear understanding of the FFS limitations that may influence the stall event training and checking including:

- Significant deviations from a particular FFS's acceptable training envelope; and
- G loading awareness/accelerated stall—factors absent from the FFS's cues that could be experienced in flight and the effect on the airplane behavior and recovery considerations.

2-5. RECOVERY PROCEDURES. This AC emphasizes using the same procedure for both stall prevention and stall recovery. Previous training and evaluation profiles that required a specific set of pilot-initiated, precise entry 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. Recovery procedures now emphasize:

- Disconnecting the autopilot and autothrottle/autothrust systems,
- Reducing the airplane's AOA immediately,
- Controlling roll after reducing the airplane AOA,
- Managing thrust appropriately, and
- Returning the airplane to the desired flightpath.

2-6. FLIGHT STANDARDIZATION BOARD (FSB) REPORTS. When developing stall prevention and recovery training, air carriers should consult the FSB report, if available, for the specific airplane type. The Training Areas of Special Emphasis, and any other recommendations pertaining to stall, should be reviewed.

CHAPTER 3. GROUND/ACADEMIC TRAINING

3-1. ACADEMIC KNOWLEDGE. Academic instruction establishes the foundation from which situational awareness, insight, knowledge, and skills are developed. Academic knowledge should proceed from the general to the specific. Including accident, incident, Aviation Safety Action Program (ASAP), flight operations quality assurance (FOQA), or Aviation Safety Reporting System (ASRS) data from stall-related 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 (AURTA) Revision 2 on stall aerodynamics and high altitude stalls into air carrier stall training programs. The AURTA Revision 2 is available at: http://www.faa.gov/other_visit/aviation_industry/airline_operators/training/media/AP_UpsetRecovery_Book.pdf.

3-2. KNOWLEDGE AREAS. The following knowledge areas should be included in all airplane training curriculums:

a. **Recovery Procedures.** Proper recovery procedures should emphasize that a reduction of the AOA is required to initiate recovery of all stall events. Additional information to incorporate into recovery training includes:

(1) Recognition of impending stall indications and understanding of the need to initiate the stall recovery procedure at an impending stall.

(2) Recognition of full stall indication (see paragraph 1-7) with the realization that most swept-wing transport category aircraft exhibit full stall characteristics different from those typically experienced in General Aviation (GA) aircraft used during certification training.

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

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

(5) Structural considerations, including explanation of limit load, ultimate load, and the dangers of combining accelerative and rolling moments (i.e., the rolling pull) during recovery.

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

(7) AOA must be reduced prior to controlling roll.

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

(9) If a terrain awareness warning system (TAWS) warning is encountered during recovery from a low altitude stall event, recovery from the stall warning should take precedence. Once the airplane recovers from the stall event, then execute the TAWS escape maneuver.

b. Factors Leading to a Stall Event. An awareness of the factors that may lead to a stall event during automated and manual flight operations including:

- AOA versus pitch angle;
- Rate of onset including rate of airspeed decay (both low and high);
- Airplane configuration and condition including weight, center of gravity (CG), landing gear, flaps/slats, spoilers/speed brakes, etc.;
- Asymmetric loading including thrust asymmetries, wing loading due to roll or yaw transients or uncoordinated flight;
- G loading;
- Bank angle;
- Thrust and lift vectors;
- Thrust required versus thrust available;
- Wind shear;
- Altitude;
- Mach effects;
- Situational Awareness;
- Mode confusion, including unexpected/unannounced mode changes;
- Unexpected transition from automated to manual flight; and
- Contamination (ice), including the effect of icing on stall speed and stall warnings.

c. Airplane-Specific Systems Knowledge.

(1) Understanding of AOA indicators (if installed) or interpretation of other representations of AOA such as pitch-limit indicators or speed display symbology that can assist in stall prevention.

(2) 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 (e.g., underwing mounted engines, t-tail, propellers, etc.).

(3) For envelope protected airplanes, stall protection capabilities in normal and degraded modes.

(4) Thrust settings and its application.

(5) Autothrottle/autothrust protection.

(6) Awareness of autoflight mode indications.

(7) Incorrect use of (including input errors) flightpath automated systems.

(8) 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.

d. High Altitude Considerations.

(1) Buffet boundary and margins in flight planning and operational flying.

(2) Lower margins for stall onset and recovery (i.e., coffin corner) and possible buffet cueing differences on the high-speed versus the low-speed margin.

(3) Principles of high altitude aerodynamics, performance capabilities, and limitations; including high altitude operations and flight techniques (i.e., the need to avoid secondary stall by extended nose-down recovery, compared to lower altitudes).

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

e. Airplane Certification Differences. Differences between transport category airplane certification and GA airplane certification regarding use of flight controls at high AOA. For example, if the roll control system is compromised and the ailerons are unable to produce the required roll recovery, the rudder may be used with care during stall prevention and recovery. To maintain structural integrity, it is important to guard against control reversals—avoid rapid full-scale reversal of control deflections.

f. Example Events. Although significant emphasis should be placed on preventing stall events, it is important for pilots to understand that, although rare, stall events continue to occur. Studying the causes and contributing factors of stall events give pilots more knowledge to help prevent or if necessary, recover from a stall event. A review of stall-related accidents, incidents, ASAP, FOQA, and ASRS data for the specific airplane type or class should be included in ground training.

CHAPTER 4. STALL PREVENTION TRAINING AND CHECKING

4-1. GENERAL. This chapter provides specific information for training and checking stall prevention (formerly approach-to-stall), which is required by 14 CFR part 121 appendices E and F. 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.

4-2. SIMULATOR TRAINING (§ 121.424). Training providers are encouraged to use the highest level FFS available when developing their stall prevention and recovery training curriculums. The primary emphasis is to provide the pilot with the most realistic environment possible during impending stall training and checking. Simulator training can either be maneuver-based or scenario-based; checking should be maneuver-based. Both methods are discussed in detail below.

a. Low Speed Alert. During maneuver-based stall prevention training and checking, pilots should apply the stall recovery at stall warning (see paragraph 1-7), not at a low speed alert or low energy alert (e.g., "airspeed low, airspeed low," "speed, speed, speed," or a flashing airspeed warning cue). Initiating the stall recovery at a low airspeed alert in maneuver-based stall prevention training or checking does not satisfy the objective of training or checking the stall recovery procedures. During scenario-based stall prevention training, pilots should return the aircraft to a desired aircraft state if any low airspeed or low energy alert is encountered.

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

b. Maneuver-Based Training. This training focuses on the mastery of an individual task or tasks. Maneuver-based training applies to both prevention and recovery training. It should emphasize the development of the required perception and motor skills to satisfactorily accomplish stall prevention and recovery. Limited emphasis should be placed on decisionmaking skills during maneuver-based training.

(1) Configurations. Maneuver-based training should include impending stalls in the following configurations required by part 121 appendix E and § 121.424:

- Takeoff or maneuvering,
- Clean, and
- Landing.

(2) Conditions. Impending stalls in the above three configurations should be trained using the following conditions, as appropriate:

- (a) Level flight and turns using a bank angle of 15 to 30 degrees;
- (b) Manual and automated (autopilot and/or autothrottle/autothrust, if installed) flight;

NOTE: It may be difficult to use autothrottle/autothrust during maneuver-based training, since the autothrottle/autothrust is usually disconnected and thrust reduced to idle. However, it is important to teach disconnecting the autopilot and autothrottle/autothrust during stall prevention training and, if the integration of the autoflight systems permit it, to develop scenarios with the autothrottle/autothrust engaged.

- (c) Visual and instrument flight conditions;
- (d) High altitudes near the airplane's maximum altitude and low altitudes within 500 feet above ground level (AGL); and
- (e) Various weights and CG locations within airplane limitations.

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

(a) Recovery Procedures.

1. Reducing AOA is the proper way to recover from a stall event. Pilots must accept that reducing the airplane's AOA will normally 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 will likely require losing several thousand feet.

2. Declare an emergency if necessary. Do not delay recovery due to degrading airspeed or a stall event to obtain air traffic control (ATC) clearance to a lower altitude.

3. 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.

4. An abrupt pitch-up or trim change can occur when the autopilot unexpectedly disconnects during a stall event. This dramatic pitch-up or trim change typically adds an unexpected physical challenge to the pilot when trying to reduce AOA. In some airplanes, this may be aggravated by an additional pitch up when the pilot increases thrust during stall recovery.

5. Secondary stall warnings are indicative of a pilot prioritizing minimum loss of altitude over proper stall recovery or flight control inputs that are too aggressive. In some airplanes, depending on AOA representations, it may be difficult to determine the point where the pitch can begin to be increased and a momentary secondary stall warning may be

encountered. A secondary stall warning is acceptable as long as AOA is promptly reduced and the airplane's limitations are not exceeded.

6. Air carriers should develop stall prevention evaluation strategies that are a direct reflection to the aircraft type. Between different aircraft types and variations of an aircraft type there is a broad range of available airspeed/AOA/energy information to the pilot. Therefore, an evaluation of a stall prevention with an attitude direction indicator (ADI) that has sufficient information to determine the flight envelope (pitch limit indicators, speed tape with low speed awareness, airspeed trend needles) should be more stringent. Obviously with this expectation, the assumption is made that the air carrier's stall training prepares the pilot to interpret this information in low energy states. Conversely, a stall prevention evaluation of a pilot that has limited flight envelope information could allow momentary reactivations of the stall warning after the pilot has reduced the AOA to cease the stall warning and is attempting to return the aircraft to safe flight.

(b) Factors Leading to a Stall Event.

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

2. Inappropriate use or inadequate monitoring of autoflight modes can be a contributing factor to a stall event. For example, climbing in vertical speed can lead to a stall event when pilots do not notice the airspeed reducing as the altitude increases; whereas, climbing in modes such as indicated airspeed or flight level change can protect against unnoticed deceleration in a climb.

(c) Airplane-Specific Knowledge.

1. Impending stall characteristics for the specific airplane, including buffeting of a severity that may make it difficult to read the instruments.

2. Review of AOA indicators (if installed) or interpretation of other representations of AOA such as pitch-limit indicators or speed display symbology that can assist in stall prevention.

3. Noises associated with stick shakers, autopilot, and autothrottle/autothrust disconnect alarms can cause confusion in the cockpit.

4. The effects of malfunctioning or deferred equipment on stall protection and stick pusher systems.

(d) Altitude Effects.

1. Differences between high and low altitude stalls, pitch rate sensitivity of flight controls (due to lack of aerodynamic damping), and amount of altitude loss required for recovery.

2. Thrust available for recovery, and lack of airflow through engines at high AOA (reinforces reduction of AOA must precede any increase of thrust).

c. Scenario-Based Training (SBT). The goal of SBT is to develop decisionmaking skills relating to stall prevention and recovery during Line-Oriented Flight Training (LOFT). Emphasis should be placed on preventing conditions that may lead to a stall event. SBT would normally be used after a pilot demonstrates proficiency in maneuver-based training and during advanced stages of training, such as upgrade training and recurrent training.

(1) Scenarios. When possible, scenarios should include accident, incident, ASAP, FOQA, and/or 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 3.

(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. However, situations may arise where pilots exhibit excellent stall prevention skills and initiate a recovery prior to the complete unfolding of a scenario. That is the desired objective. In those instances, the instructor has the discretion whether to repeat the scenario and then showing and discussing how the many cues typically cascade as the event progresses. Such explanations can reinforce a pilot's knowledge and allow sharpening of awareness and prevention skills.

4-3. USING SURPRISE IN TRAINING. Surprise has been a factor in stall incidents and accidents. Although it may be difficult to create surprise in the training environment, if achieved, surprise events may provide a powerful lesson for the crew. The goal of using surprise in training is to provide the crew with a surprise experience to reinforce timely application of the effective recovery technique under potentially confusing circumstances. Considerable care should be used in surprise training to avoid a negative learning experience. Surprise should not be used during checking. Stall prevention training should incorporate event conditions and variables typical of an unintentional stall that are likely to result in surprise due to the unexpected stall development, presentation, and behavior.

4-4. CHECKING PARAMETERS. The check pilot is responsible for establishing the flight conditions associated with the impending stall configuration being checked. The pilot may fly the entry profile but is not being checked on the entry, except for recognition of the deteriorating flight situation. The satisfactory completion of the event is based on the pilot's timely and proper recognition of the impending stall and then proper application of the stall recovery procedure.

4-5. CHECKING CRITERIA. Checking of prevention, recognition, and recovery from an impending stall should be evaluated on the timely and proper response to the impending stall including effective use of available energy; the criteria should not focus on altitude loss. The check pilot should consider the variables present at the time of the impending stall and their effect on the recovery. Checking criteria are:

- Prompt recognition of impending stall,
- Correct application of the stall recovery procedure, and
- Recovering without exceeding the airplane's limitations.

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

4-6. REALISTIC SETTINGS FOR CHECKING. In the FFS, the stall prevention checking module should be maneuver-based with an entry altitude consistent with normal operating environments. The entry parameters, including Weight and Balance (W&B), should be within airplane limitations to ensure adequate performance for recovery from an impending stall. During checking, the pilot should be checked on recovering from the impending stall.

4-7. DEBRIEFING. Debriefing pilots on their performance in both training and checking is essential. Providing pilots with specific feedback on the recovery procedures including whether recovery control inputs were excessive, insufficient, or had cyclic control reversals will assist pilots in improving their recovery procedures and will also address the implications of G loading differences in simulation. If the recovery exceeds the limitations of the FSTD, instructors must make the pilot aware to avoid negative transfer of training.

CHAPTER 5. STALL RECOVERY TRAINING

5-1. GENERAL. This chapter provides specific information for training stall recovery, which is an instructor-guided, hands-on experience of applying the stall recovery procedure for a full stall. Recovery from a full stall, including stick pusher activation, if equipped, is required by § 121.423, but is not checked.

5-2. FULL STALL TRAINING. Full stall training provides pilots with the hands-on experience of the airplane handling characteristics and cues (e.g., increased buffet, reduced stability and control, and roll off) near and at full stall. The focus of full stall training should be maneuver based. Scenario-based training is better reserved for assessing stall prevention skills. In addition to providing the full stall experience, the following emphasis items should be highlighted by the instructor:

- Discussion of the objective of increasing the AOA beyond an impending stall to experience full stall characteristics, as these full stall characteristics may be significantly different from those they experienced in flying lighter aircraft in their primary training.
- Differences in flight cues and flight/control characteristics in full stall as compared to cues in stall prevention training. If an aircraft exhibits more than one of the ways a full stall is defined, these conditions should be trained.
- Proper recovery once full stall is identified. If full stall is represented by stick pusher activation, pilots must allow the stick pusher to activate before completing the recovery.

5-3. FULL STALL TRAINING MANEUVER. During training for full stall, the pilot may be asked, for demonstration purposes, to call out some aural and visual indications of the impending stall, but defer response until directed to recover, in order to experience the aircraft's handling qualities in the full stall regime. Such training provides the pilot with an instructor-guided, hands-on experience of recovering from a full stall. Appendix 4 includes an example of Full Stall Experience Training.

5-4. STICK PUSHER. For airplanes equipped with a stick pusher, stall recovery training includes ground training and practical training in an FFS. It is important for pilots to experience the sudden forward movement of the control yoke/stick during a stick pusher activation. From observations, most instructors state that, regardless of previous academic training, pilots usually resist the stick pusher on their first encounter. Usually, they immediately pull back on the control yoke/stick rather than releasing pressure as they have been taught. Therefore, pilots must receive practical stick pusher training in an FFS 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. Pilot response to a deliberate activation of the pusher is not a checked maneuver.

APPENDIX 1. STALL RECOVERY TEMPLATE

1. METHODOLOGY. Airplane manufacturers (Airbus, ATR, Boeing, Bombardier, and Embraer) provided input for the creation of a stall recovery template that provides commonality among various airplanes. The basic steps were identifying airplane differences (e.g., 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 straightforward and effective 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.

2. STALL RECOVERY TEMPLATE. The stall recovery template developed with input from the 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 Table 1 due to specific airplane characteristics. Specific items, such as configuration changes (e.g., 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 necessary due to airplane operating characteristics. For operators of airplanes without a manufacturer stall recovery procedure, the FAA recommends using the stall recovery template as a reference when developing operator specific stall recovery procedures.

NOTE: Reduction of AOA must be paramount in all stall prevention and recovery procedures. Operators should consult with their airplane manufacturer(s) to ensure they have the proper stall prevention and recovery procedure. Outdated procedures should be updated in accordance with this guidance.

TABLE 1. STALL RECOVERY TEMPLATE (WITH ASSOCIATED RATIONALE)

1	Autopilot and autothrottle/autothrust.....Disconnect
Rationale	While maintaining the attitude of the airplane, disconnect the autopilot and autothrottle/autothrust. 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/autothrust 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 impending stall indications are 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 2. SAMPLE DEMONSTRATIONS

1. Two demonstrations were constructed using the philosophies and concepts described in this AC. The first is an impending stall recovery with only idle thrust available that emphasizes the need to reduce the 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.

DEMONSTRATION 1: IMPENDING STALL RECOVERY WITH ONLY IDLE THRUST AVAILABLE

OBJECTIVE	The pilot will recover from an impending stall by reducing the AOA without applying thrust. 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 impending stall.
EMPHASIS AREAS	<ul style="list-style-type: none"> Crew coordination, and AOA management.
FFS SETUP CONSIDERATIONS	This demonstration may be completed in any airplane configuration or any altitude that allows a recovery.
DEMONSTRATION ELEMENTS	<ul style="list-style-type: none"> At level flight, reduce thrust to idle. Increase AOA to achieve conditions for an impending stall without regard to holding altitude. At the impending stall, direct the crew to recover solely by lowering the nose to reduce the AOA. The demonstration is performed with idle thrust.
COMPLETION STANDARDS	The instructor will advise the pilot that the maneuver is complete when the pilot understands the need to reduce AOA for stall recovery.

DEMONSTRATION 2: STICK PUSHER DEMONSTRATION (IF INSTALLED)

OBJECTIVE	<p>The pilot will allow the stick pusher to reduce the AOA and then perform the correct recovery procedure without resisting the stick pusher.</p> <p>The pilot understands that stick pusher activation must be relied upon and not overridden. In some airplanes, 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 an aerodynamic stall and possible loss of control. The pilot should be able to perform the appropriate actions should a stick pusher activation occur.</p>
EMPHASIS AREAS	<ul style="list-style-type: none"> • Recognition. • Crew coordination. • AOA management: Allow the pusher to reduce the AOA. • Audible and visual warnings (environment and airplane cueing). • Effects of altitude on recovery. • Demonstrate and re-emphasize all impending stall cues and remind the pilot that in normal circumstances the pilot should recover if any of these cues occur. For the purpose of this demonstration, these cues will be noted but not acted upon to experience the stick pusher activation. • 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.
FFS SET UP CONSIDERATION	This demonstration may be completed in any airplane configuration or any altitude that allows for a recovery.
DEMONSTRATION ELEMENTS	<ul style="list-style-type: none"> • In level flight, reduce thrust to idle. • AOA should be increased to achieve the activation of the stick pusher. • Review impending stall indications as they occur. • Upon stick pusher activation, direct the crew to allow the pusher activation and then initiate recovery procedure.
COMPLETION STANDARDS	<ul style="list-style-type: none"> • 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. • There is no predetermined value for altitude loss, and maintaining altitude during recovery is not required.

APPENDIX 3. 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 impending 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.

SCENARIO 1: CLEAN CONFIGURATION STALL PREVENTION (HIGH ALTITUDE)

INSTRUCTOR ROLE	Implement scenarios that result in an unexpected impending stall near the airplane's maximum operating altitude.
OBJECTIVE	The pilot will recognize the impending stall and immediately perform the stall recovery procedure. The pilot should demonstrate willingness to trade altitude for airspeed to accomplish an expeditious recovery.
EMPHASIS AREAS	<ul style="list-style-type: none"> • Recognition and recovery. • Crew coordination. • AOA management. • Out-of-trim control forces at autopilot disconnect (if engaged). • Aural and visual warnings (environment and airplane cuing). • Surprise. • Reduced roll stability and increased buffeting. • Climbing at a slower than normal airspeed and higher than normal vertical speed may result in leveling off at a speed below that which can be maintained at the thrust available. • The role of increasing temperature and turbulence on high altitude performance. • Effects of multiple levels of automation. • Effects of altitude on recovery. • Knowledge of the aircraft's high- and low-speed buffet boundaries. • Thrust available versus thrust required to maintain altitude. • There is no predetermined value for altitude loss, maintaining altitude during recovery is not required, and the recovery will likely take several thousand feet. • Situational awareness while returning to desired flightpath after the stall recovery, including such items as heading, altitude, other aircraft, and flight deck automation.
FFS SETUP CONSIDERATIONS	This scenario will be conducted near maximum operating altitude for the specific airplane weight and temperature. Crew distractions (e.g., minor malfunctions, air traffic control (ATC) instructions, weather) and simulator capabilities may be used to induce

	impending stalls. Scenarios from actual events, such as climbing in vertical speed mode, which will result in the airplane leveling off at an airspeed behind the power curve can also be used.
SCENARIO ELEMENTS	<ul style="list-style-type: none"> • At level flight with the autopilot on, introduce an event or reduce thrust to less than adequate for maneuvering flight. • Upon recognizing the impending stall, perform the stall recovery procedure. • The necessity for smooth, deliberate, and positive control inputs to avoid excessive load factors and secondary stalls.
COMPLETION STANDARDS	<ul style="list-style-type: none"> • The pilot will perform a deliberate and smooth reduction of AOA. • Positive recovery from the stall event is paramount. There is no predetermined value for altitude loss and maintaining altitude during recovery is not required. • Appropriate application of thrust to accelerate and enable a positive recovery. • Establishing the appropriate AOA takes precedence over roll control (attempting to maintain wings level) for positive recovery from the stall event. • Intermittent secondary stall warnings, but not secondary stalls, may be acceptable due to the associated recovery challenges at altitude because of the lack of aerodynamic damping. • The maneuver is considered complete once a safe speed is achieved and the airplane stabilized. • Satisfactory crew coordination must be demonstrated.
COMMON PILOT ERRORS	<ul style="list-style-type: none"> • Recovery is attempted with thrust instead of reducing AOA. • Not maintaining a nose-down input until the impending stall cues are eliminated. • Insufficient pitch down to allow desired energy conversion of altitude to airspeed. • Pilot fails to promptly recover from a secondary stall. • Reluctance to sacrifice significant altitude. • Pilot fails to distinguish between high-speed buffet and low-speed stall. • Pilot increases the load factor too quickly and gets multiple impending stalls or a stick pusher activation. • Inappropriate use of rudder. • Pilot prioritizes roll control (attempting to level the wings) before reducing AOA. • Not disconnecting the autopilot and/or autothrottle/autothrust prior to reducing AOA.

SCENARIO 2: TAKEOFF CONFIGURATION STALL PREVENTION

INSTRUCTOR ROLE	Implement scenarios that result in an unexpected impending stall on departure prior to flaps being fully retracted.
OBJECTIVE	The pilot will recognize the impending stall and immediately perform the stall recovery procedure, then resume the assigned departure.
EMPHASIS AREAS	<ul style="list-style-type: none"> • 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. • Reduced roll stability and increased buffeting. • Effects of multiple levels of automation. • Effects of altitude on recovery. • Situational awareness 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.
FFS SETUP CONSIDERATIONS	The scenario will be conducted during takeoff and/or departure, at an altitude that will allow for a recovery. Crew distractions (e.g., minor malfunctions, ATC instructions, weather) and simulator capabilities may be used to induce impending stalls.
SCENARIO ELEMENTS	<ul style="list-style-type: none"> • During departure, reduce thrust to less than adequate to maintain airspeed and climb rate. • Upon recognizing the impending stall, perform the stall recovery procedure. • When recovery is assured, adjust the pitch attitude to initiate a climb to the assigned departure altitude.
COMPLETION STANDARDS	<ul style="list-style-type: none"> • The pilot will perform a deliberate and smooth reduction of AOA. • Positive recovery from the stall event takes precedence over minimizing altitude loss or roll control (attempting to maintain wings level before appropriate AOA is established). • Appropriate application of thrust to accelerate and enable an expeditious recovery. • The return of the airplane to safe flight without encountering secondary stall warnings. • The maneuver is considered complete once the flight reaches and stabilizes at the assigned departure altitude. • Satisfactory crew coordination must be demonstrated.

COMMON PILOT ERRORS	<ul style="list-style-type: none"> • Recovery is attempted with no loss of altitude. • Recovery is attempted without recognizing the importance of pitch control and AOA. • Pilot prioritizes roll control (attempting to level the wings) before reducing AOA. • Inappropriate use of rudder. • Not disconnecting the autopilot and/or autothrottle/autothrust prior to reducing AOA. • Not maintaining a nose-down input until the impending stall cues are eliminated. • Pilot increases the load factor too quickly and gets multiple impending stalls or a stick pusher activation. • Rolling wings level prior to AOA reduction. • Failure to roll wings level after AOA reduction to improve performance. • Losing situational awareness and failing to return to assigned flightpath or follow ATC instructions after recovery.
----------------------------	---

SCENARIO 3: LANDING CONFIGURATION STALL PREVENTION

INSTRUCTOR ROLE	Implement scenarios that result in an unexpected impending stall during an approach.
OBJECTIVE	The pilot will recognize the impending stall and immediately perform the stall recovery procedure, then commence missed approach.
EMPHASIS AREAS	<ul style="list-style-type: none"> • 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. • Reduced roll stability and increased buffeting. • Effects of multiple levels of automation. • Effects of altitude on recovery. • Situational awareness 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. Maintaining altitude is not required.

FFS 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 (e.g., minor malfunctions, ATC instructions, weather) and simulator capabilities may be used to induce impending stalls.
SCENARIO ELEMENTS	<ul style="list-style-type: none"> • 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 recognizing the impending stall, perform the stall recovery procedure. • When recovery is assured, adjust the pitch attitude to initiate a climb to comply with missed approach instructions.
COMPLETION STANDARDS	<ul style="list-style-type: none"> • The pilot will perform a deliberate and smooth reduction of AOA. • Positive recovery from the stall event takes precedence over minimizing altitude loss or roll control (attempting to maintain wings level before appropriate AOA is established). • Appropriate application of thrust to accelerate and enable an expeditious recovery. • The return of the airplane to safe flight without encountering secondary stall warnings. • 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 PILOT ERRORS	<ul style="list-style-type: none"> • Recovery is attempted with no loss of altitude. • Recovery is attempted without recognizing the importance of pitch control and AOA. • Inappropriate use of rudder. • Pilot prioritizes roll control (attempting to level the wings) before reducing AOA. • Not disconnecting the autopilot and/or autothrottle/autothrust prior to reducing AOA. • Not maintaining a nose-down input until the impending stall cues are eliminated. • Pilot increases the load factor too quickly and gets multiple impending stalls or a stick pusher activation. • Rolling wings level prior AOA reduction. • Failure to roll wings level after AOA reduction to improve performance. • Losing situational awareness and failing to return to assigned flightpath and complete a missed approach, or follow ATC instructions after recovery.

Other suggested scenarios include:

1. After level-off from a descent with idle thrust, the pilot either forgets to increase thrust or on airplanes equipped with autothrottle/autothrust, the autothrottle/autothrust does not increase thrust.
2. While at low altitude and maneuvering, banking at slow speeds.
3. During approach, while slowing to approach speed, the pilot does not add flaps soon enough or does not closely watch the energy trend.
4. The flight crew is instructed to climb to an altitude within the airplane's certified flight envelope, but is not possible to maintain given the weight and temperature conditions.

APPENDIX 4. SAMPLE FULL STALL TRAINING MANEUVER

NOTE: Considerable evaluation of the FFS must occur before conducting full stall training in simulation. Reference Appendix 5 for all FFS evaluation considerations.

Training to full stall must be instructor led with a discussion of the learning objectives. Particular emphasis must be placed on the potential negative effects of training that traverses impending stall conditions to reach a full stall.

The goals of the training are (a) to provide the pilots the experience of the handling characteristics and dynamic cues (e.g., buffet, roll off) near and at full stall and (b) to reinforce the proper application of the stall recovery procedures.

Future full stall FFS models may contain a randomness feature that will allow a pilot to experience the in-flight variations in full stall characteristics. That is, no two real stalls are alike. Performing this maneuver more than once, with perhaps instructor selection of stall response severity, could show a pilot both average and extreme response of a full stall.

This example is not intended to be limiting in any way, it is provided as a framework for developing a training curriculum.

NOTE: Reduction of AOA must be paramount in all stall prevention and recovery procedures. Operators should consult with their airplane manufacturer(s) to ensure they have the proper stall prevention and recovery procedure. Outdated procedures should be updated in accordance with this guidance.

SCENARIO: FULL STALL EXPERIENCE TRAINING

INSTRUCTOR ROLE	Instructor-guided, pilot hands-on maneuver training.
OBJECTIVE	Provide pilot(s) the experience of the airplane's handling characteristics near and at full stall, the related cues, and full stall recovery.
EMPHASIS AREAS	<ul style="list-style-type: none"> • 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). • Reduction of roll stability and increased buffeting. • Effects of multiple levels of automation. • Effects of altitude on recovery.

	<ul style="list-style-type: none"> Situational awareness while returning to desired flightpath after the stall, including such items as heading, terrain, altitude, other aircraft, and flight deck automation. There is no predetermined value for altitude loss. Maintaining altitude is not required.
FFS SETUP CONSIDERATIONS	<ul style="list-style-type: none"> This maneuver based training exercise must be conducted at an altitude that will allow for a recovery. Setup may be conducted on autoflight to allow for instructor-led discussion of expected cues and cautions (if feasible).
SCENARIO ELEMENTS	<ul style="list-style-type: none"> Create a situation which will result in a stall, such as reducing thrust to less than adequate to maintain airspeed and climb rate or adjusting flightpath by varied means including changes to vertical rates, entering turn, etc., to yield an adverse energy trend. Upon pilot recognition of the impending stall, the instructor will encourage the further increase of AOA in order to reach full stall while highlighting the impending stall cues.
COMPLETION STANDARDS	<ul style="list-style-type: none"> The pilot will perform a deliberate and smooth reduction of AOA. Positive recovery from the full stall 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 altitude. Satisfactory crew coordination must be demonstrated.
COMMON PILOT ERRORS	<ul style="list-style-type: none"> 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 after AOA reduction to improve performance. Losing situational awareness and failing to return to assigned flightpath or follow ATC instructions after recovery. Inappropriate use of rudder. Not disconnecting the autopilot and/or autothrottle/autothrust prior to reducing AOA.

APPENDIX 5. FULL FLIGHT SIMULATOR CONSIDERATIONS

1. SUMMARY OF SIMULATOR CAPABILITIES. Full flight simulators (FFS) that are appropriately qualified by the FAA can be used for stall prevention training as described below. Full stall training and stick pusher demonstrations will require additional FFS evaluation. The current 14 CFR part 60 flight simulation training device (FSTD) qualification standards only include approaches to stall as a minimum qualified task for FSTD Levels A–D (refer to part 60 appendix A, Table A1B, Table of Tasks vs. Simulator Level, section 3.b.1). In March 2016, the FAA published changes to the part 60 rule which added new FSTD evaluation standards for the qualification of full stall training tasks¹. This rule change includes requirements for FSTDs that are initially evaluated after the effective date of the rule as well as retroactive requirements for grandfathered FSTDs that will be used to conduct such training tasks. As a result, after March 12, 2019, any FSTD being used to conduct full stall training tasks must be issued additional qualification to conduct these tasks as described in part 60, § 60.16. Training providers desiring to conduct full stall training as part of an FAA-approved flight training program are encouraged to review the National Simulator Program's (NSP) guidance bulletin on evaluating an FFS for full stall training (FSTD Qualification Guidance Bulletin 14-01, FSTD Evaluation and Qualification for Full Stall Training Tasks) and the contents of this appendix before making a request for additional qualification. NSP guidance bulletins may be found on the FAA's website at <http://www.faa.gov/about/initiatives/nsp/>.

a. Stall Prevention Training Maneuvers.

(1) To ensure a high level of FFS fidelity, stall prevention training maneuvers should be conducted in conditions similar to objectively evaluated test conditions where possible (e.g., airplane weight, environmental conditions, stall entry rates, etc.). Current objective testing requirements for FFS qualification are for second segment climb and approach/landing flight conditions. The FSTD Master Qualification Test Guide (MQTG) should be reviewed to assist in determining maneuvers that are likely to have a high level of fidelity. Since stall prevention training will typically take place well within an angle of attack (AOA) range in which the aerodynamic model has been objectively validated, it is not expected that significant modifications to the FSTDs will be required to conduct this training.

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

(a) Objective evaluation of stall warning and stall buffet speeds against published airplane data (such as Airplane Flight Manual (AFM) stall tables).

(b) An assessment of the FSTD's stall characteristics by a subject matter expert (SME) pilot with experience in the impending stall characteristics of the represented airplane.

¹ Refer to Flight Simulation Training Device Qualification Standards for Extended Envelope and Adverse Weather Event Training Tasks (14 CFR part 60, 81 FR 18177).

b. Stall Recovery Training. For training to full stall, additional testing and validation of the specific FFS is necessary because of the variations among FFSs. While some FFSs may have the fidelity allowing training past impending stall conditions, the potential of negative transfer of training exists if simulated flight in this regime is not properly evaluated (through objective testing and evaluation by an SME pilot with experience in the stall characteristics of the airplane). The FAA has codified FSTD evaluation requirements for full stall training tasks into part 60, FSTD Directive 2, which became effective on May 31, 2016.

c. Stick Pusher Demonstrations. FFSs may be used to demonstrate the activation of a stick pusher system (if installed); however, training providers are cautioned that the airplane dynamics following a stick pusher activation may not accurately represent the airplane unless the FFS is properly modeled and evaluated. To ensure an adequate level of fidelity for stick pusher demonstrations, training providers should conduct additional testing and validation 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, to include:

- (1) The stick pusher activation speeds (or associated AOAs) should be objectively evaluated against published airplane data (such as the AFM stall tables).
- (2) The modeling of the stick pusher system or stall protection system should be based upon airplane Original Equipment Manufacturer (OEM)-provided simulation data or other suitable data to ensure correct activation speeds/AOAs and cancellation logic.
- (3) The simulated stick pusher control forces and displacements should be validated against airplane-collected or OEM-provided validation data to ensure the FFS provides the correct control loading force cues.
- (4) Since a stick pusher demonstration maneuver will typically occur at AOAs beyond the activation of the stall warning system, the FFS should be evaluated for satisfactory performance and handling qualities by an appropriately qualified SME pilot.

(5) As described in part 60, FSTD Directive 2, FFSs that are used to conduct full stall training tasks in an FAA-approved flight training program (including stick pusher demonstrations that exceed the stall warning AOA) must be qualified to do so after March 12, 2019.

2. BACKGROUND INFORMATION. Currently, FSTD qualification standards are defined in 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 stall prevention and full stall training tasks in currently qualified FFSs. It was determined that previously qualified FFSs may not be capable of conducting training tasks to a full stall. The primary factors for this determination are as follows:

- a. Until recently, flight training requirements were limited to impending stall maneuvers as opposed to full stall maneuvers. As a result, most current FFS stall training does not extend to AOAs much higher than that for an impending stall.

b. While much of the development of an FFS's aerodynamic model at AOAs below the stall AOAs can assume a certain extent of linearity in extrapolating performance and handling characteristics, this assumption is not valid at, or past, full stall where the airplane dynamics and control characteristics may become nonlinear or unstable.

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

3. PART 60 CHANGE. Through the collaborative efforts and recommendations from various working groups and international committees, the FAA issued a final rule to update the FSTD qualification standards in part 60. These changes became effective May 31, 2016, and include new evaluation requirements to qualify FSTDs for full stall training and other training tasks. In order to use an FSTD to conduct full stall training tasks in an FAA approved flight training program, sponsors must apply for the additional FSTD qualification as described in part 60, FSTD Directive 2 (Attachment 6 to appendix A of part 60). FSTDs that are found to meet the requirements of FSTD Directive 2 will have their Statements of Qualification (SOQ) amended to reflect qualification of these additional training tasks. As stated in FSTD Directive 2, the compliance date for the FSTD qualification of full stall training tasks is March 12, 2019. After March 12, 2019, any FSTD used to conduct full stall training must be evaluated and issued additional qualification by the National Simulator Program Manager (NSPM) as defined in part 60, FSTD Directive 2.

Advisory Circular Feedback Form

If you find an error in this AC, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by contacting the Air Transportation Division (AFS-200) at 9-AWA-AVS-AFS-200-Air-Transportation-Division@faa.gov or the Flight Standards Directives Management Officer at 9-AWA-AFS-140-Directives@faa.gov.

Subject: AC 120-109A CHG 1, Stall Prevention and Recovery Training

Date: _____

Please check all appropriate line items:

An error (procedural or typographical) has been noted in paragraph _____
on page _____.

Recommend paragraph _____ on page _____ be changed as follows:

In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

Other comments:

I would like to discuss the above. Please contact me.

Submitted by: _____

Date: _____