



EASA Safety Information Bulletin

SIB No.: 2013-02
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- Subject:** **Stall and Stick Pusher Training**
- Ref. Publications:** FAA Advisory Circular [120-109](#)
 FAA [Aeroplane Upset Recovery Training Aid](#)
 Aircrew Regulation 1178/2011 (Part-FCL, Part-ORA) and Air Operations Regulations 965/2012 (Part-ORO) – see [European Flight Standards Implementing Rules](#).
- Applicability:** Fixed Wing aeroplane manufacturers, Operators and Training Organisations.
- Background:** Based on accident review, a concern has arisen within the Aviation Community regarding loss of control (LoC) accidents. In this type of accident, quite often the pilot's inappropriate reaction to the first indication of a stall or stick pusher event is a key factor.
- It is widely recognised that sometimes pilots are failing to avoid conditions that may lead to a stall, or failing to recognise the onset of an approach-to-stall during routine operations in both manual and automatic flight. Sometimes pilots may not have the necessary skills or competencies to appropriately respond to an unexpected stall or stick pusher event.
- Stall and approach to stall training should always emphasise reduction of the Angle of Attack (AOA) as the most important response when confronted with any stall event.
- Description:** Based on these findings, a comprehensive approach to stall and stick pusher training was developed, under the supervision of the FAA and with the participation of the EASA. This included a review of recommended practices developed by major aeroplane manufacturers, pilot associations, operators, training organisations, simulator manufacturers, and industry representative organisations.
- The first result was a FAA Advisory Circular (AC 120-109) meant to provide best practices and guidance for training, testing, and checking of pilots, within the existing regulatory framework, to ensure correct and consistent responses to unexpected stall warnings and stick pusher activations.

This is information only. Recommendations are not mandatory.

The purpose of this SIB is to provide recommendations to operators, aeroplane manufacturers and training organisations, based on the FAA AC 120-109, for best practices on training and checking on stall warnings, aerodynamic stalls and stick pusher activations, and recommended recovery procedures, with the aim of improving overall safety.

Chapter 5 in the Annex of this SIB includes a stall recovery template, developed by Aeroplane manufacturers (Airbus, ATR, Boeing, Bombardier and Embraer), which provides commonality among various aeroplanes and could be used by current and future aeroplane manufacturers to develop aeroplane-specific stall recovery procedures.

EASA promotes the use of that template, and has planned further actions, including rulemaking tasks related to stall and LoC training, based on accident reviews, surveys and safety recommendations.

Several specific EASA rulemaking tasks (Rulemaking programme 2013-2016) address the following related areas:

- Crew Resource Management training (RMT.0411);
- Loss of Control Avoidance and Recovery Training (RMT.0581);
- Requirements for Relief Pilots (RMT.0191);
- Large Aeroplane Certification Specifications in Super-cooled Large Drop, Mixed phase, and Ice Crystal Icing Conditions (RMT.0058);
- Sterile Flight Deck Procedures (RMT.0416);

Recommendation(s): The recommendations are listed in the Annex of this SIB.

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Definitions (for the purpose of this SIB):

- **Aerodynamic Stall.** An aerodynamic loss of lift caused by exceeding the aeroplane's critical angle of attack.
- **Angle of Attack (AOA).** The angle between the oncoming air, or relative wind, and some reference line on the aeroplane or wing.
- **Approach-to-Stall.** Flight conditions bordered by stall warning and aerodynamic stall.
- **Crew Resource Management (CRM).** Effective use of all available resources: human resources, hardware, and information.
- **First Indication of a Stall.** The initial aural, tactile, or visual sign of an impending stall, which can be either naturally or synthetically induced.
- **Flight Simulation Training Device (FSTD).** A training device which is a full flight simulator (FFS), a flight training device (FTD), a flight and navigation procedures trainer (FNPT), or a basic instrument training device (BITD).
- **Instructor Operating Station (IOS).** The interface panel between the FSTD instructor and the FSTD.
- **Landing Configuration.** When the aeroplane landing gear is down and a landing flap setting has been selected during an approach.
- **Manoeuvre-Based Training.** Training that focuses on a single event or manoeuvre in isolation.
- **Scenario-Based Training (SBT).** Training that incorporates manoeuvres into real-world experiences to cultivate practical flying skills in an operational environment.
- **Secondary Stall.** A premature increase in AOA that results in another stall event during stall recovery, prior to a stable flight condition being established.
- **Stall Event.** Anytime the aeroplane develops indications of an approach-to-stall or aerodynamic stall.
- **Stall Recovery Procedure.** The manufacturer-approved aeroplane-specific stall recovery procedure. If a manufacturer-approved recovery procedure does not exist, the aeroplane-specific stall recovery procedure developed by the operator based on the stall recovery template in Chapter 4 in the Annex of this SIB.
- **Stall Warning.** A natural or synthetic indication provided when approaching a stall that may include one or more of the following indications:
 - Aerodynamic buffeting (some aeroplanes will buffet more than others),
 - Reduced roll stability and aileron effectiveness,
 - Visual or aural cues and warnings,
 - Reduced elevator (pitch) authority,
 - Inability to maintain altitude or arrest rate of descent,
 - Stick shaker activation (if installed),
- **Stick Pusher.** A safety system that applies downward elevator pressure to prevent an aeroplane from exceeding a predetermined AOA in order to avoid, identify, or assist in the recovery of an aerodynamic stall.
- **Take-off or Manoeuvring Configuration.** The aeroplane's normal configuration for take-off, approach, go-around, or missed approach until all flaps/slats are retracted. Retractable landing gear may be extended or retracted.
- **Uncoordinated Flight.** Flight with lateral acceleration, such as slipping or skidding in a turn.
- **Undesired Aircraft State.** A position, condition, or attitude of an aircraft that reduces or eliminates safety margins, including low energy states.

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Annex - Recommendations

1. Stall training philosophy

1.1. General philosophy

An effective approach-to-stall and stall recovery training syllabus should provide pilots with 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.

1.2. Training philosophy

While basic aerodynamics and approach-to-stall and stall recovery training are typically accomplished as part of a pilot's private, commercial, MPL or airline transport pilot (ATPL) licensing, 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 aeroplane. Training providers should also understand that some pilots may need to modify previous stall recovery procedures based on their prior experience. This SIB 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 (e.g., CRM, adverse weather training, etc.). Training providers should include approach-to-stall and stick pusher (if installed) training for pilots during:

1.2.1. Initial training,

1.2.2. Type rating training,

1.2.3. Requalification training,

1.2.4. Differences training (if differences exist in stall warning or stall recovery procedure),

1.2.5. Upgrade training, and

1.2.6. Recurrent training.

1.3. Instructors and examiners standardisation

Instructors and examiners should receive training in the subject areas contained in this SIB. Knowledge of the subject areas contained in this SIB ensures accurate stall training and reinforces harmonised training, so that the risks of negative training are minimized. Instructor/examiners training should focus on the practical application of these principles and the evaluation of a pilot's understanding of the aeroplane's operating characteristics. Instructors/examiners must have a clear understanding of the FSTD limitations that may influence the approach-to-stall training/checking including:

1.3.1. A particular FSTD's acceptable training envelope;

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- 1.3.2. G loading awareness/accelerated stall—factors absent from the FSTD’s programming that could be experienced in flight and the effect on stall speed, aeroplane behaviour, and recovery considerations;
- 1.3.3. Motion cues—limitations of motion cues typically present in most simulators after the first indication of stall;
- 1.3.4. Significant deviations from validated flight manoeuvres could result in significant degradation in simulator fidelity.

1.4. Testing and checking

1.4.1. Recovery Procedures

This SIB emphasises both recognizing a stall event and completing the proper approach-to-stall recovery procedure. Training and checking has been based on 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:

- 1.4.1.1. The immediate reduction of the aeroplane’s AOA,
- 1.4.1.2. Management of thrust, and
- 1.4.1.3. Returning the aeroplane to a safe flying condition.

1.4.2. Evaluation Parameters

The examiner 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.

1.4.3. 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:

- 1.4.3.1. Prompt recognition of stall event,
- 1.4.3.2. Correct application of the approach-to-stall recovery procedure, and
- 1.4.3.3. Recovery of the aeroplane without exceeding the aeroplane’s limitations.

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1.4.5. Realistic Settings

In the FSTD, an approach-to-stall checking event may be manoeuvre-based or scenario-based with an entry altitude consistent with normal operating environments. The entry parameters, including weight and balance, should be within aeroplane 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 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).

2. Training methodology

2.1. 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 aeroplane characteristics and development of basic recovery handling skills through manoeuvre-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 impending stall, respond appropriately in situations of surprise or startle, and recover effectively when required. Training providers should develop training syllabi that provide pilots with the knowledge and skills to prevent, recognise, and recover from unexpected stall events. These training curriculums should contain the elements described in this SIB.

2.2. Ground and theoretical training

2.2.1. Theoretical Knowledge

Theoretical instruction establishes the foundation from which situational awareness, insight, knowledge, and skills are developed. Theoretical 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: EASA recommends incorporation of applicable sections of the Aeroplane Upset Recovery Training Aid on stall aerodynamics and high altitude stalls into operator's stall training programs. The Aeroplane 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

2.2.2. Aeroplane Training Syllabi

The following knowledge areas should be included in all aeroplane training syllabi:

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- 2.2.2.1. The understanding that a reduction of AOA is required to initiate recovery of all stall events (approach-to-stall and aerodynamic stall);
- 2.2.2.2. 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,
 - Centre of gravity (CG),
 - Thrust and lift vectors,
 - Thrust settings and application of thrust,
 - Auto-throttle protection,
 - Wind shear,
 - Configuration,
 - Altitude,
 - Mach effects,
 - Uncoordinated flight and improper use of rudder,
 - Misuse of automation,
 - Situational Awareness, and
 - Contamination (ice).
- 2.2.2.3. Recognition of the stall warning indications and understanding the need to initiate the stall recovery procedure at the first indication of a stall;
- 2.2.2.4. 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 behaviours that may occur with system failures;

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- 2.2.2.5. Effectiveness of control surfaces and the order in which the control surfaces may lose and regain their effectiveness (e.g., spoilers, ailerons, etc.);
- 2.2.2.6. Differences between aeroplane certification and general aviation aeroplane certification regarding use of flight controls at high AOA. For example, large aeroplanes are certified to retain the ability to raise a wing, with full aileron deflection if needed, all the way up to stick shaker;
- 2.2.2.7. Specific stall and low speed buffet characteristics unique to the aeroplane type and any implications for the expected flight operations and aeroplane-specific stall recovery procedure;
- 2.2.2.8. Proper stall recovery procedure;
- 2.2.2.9. Buffet boundary and margins in flight planning and operational flying;
- 2.2.2.10. The necessity for smooth, deliberate, and positive control inputs to avoid unacceptable load factors and secondary stalls;
- 2.2.2.11. Avoiding cyclical or oscillatory control inputs to prevent exceeding the structural limits of the aeroplane;
- 2.2.2.12. Structural considerations, including explanation of limit load, ultimate load, and the dangers of combining accelerative and rolling forces (the rolling pull) during recovery;
- 2.2.2.13. Principles of high altitude aerodynamics, performance capabilities and limitations - including high altitude operations, and flight techniques;
- 2.2.2.14. Differences in aeroplane 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;
- 2.2.2.15. Stall-related accidents, incidents and data for the specific aeroplane type or class; and
- 2.2.2.16. For aeroplanes equipped with a stick pusher, recommended recovery actions in response to stick pusher activation.
- 2.2.2.17. For FBW aeroplanes, the flight envelope protections available including stall protection in normal and degraded laws and an understanding of FBW stability and control characteristics.

3. Simulator training

Training providers are encouraged to use the highest level FFS available when developing their approach-to-stall training syllabi. The primary emphasis is providing the pilot with the

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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 behaviours that rely on motion.

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

3.1. Manoeuvre-Based Training

This training focuses on the mastery of an individual task or tasks. Manoeuvre-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 manoeuvre-based training.

3.2. Manoeuvres

Manoeuvre-based training should include the following tasks:

- 3.2.1. Take-off and Initial climb, or manoeuvring configuration approach-to-stalls,
- 3.2.2. Clean configuration approach-to-stalls, and
- 3.2.3. Landing configuration approach-to-stalls.

3.3. Stall Scenarios

The three tasks should be trained using realistic scenarios in the following conditions:

- 3.3.1. Level flight and turns using a bank angle of 15 to 30 degrees,
- 3.3.2. Manual and automated (autopilot and/or auto-throttle, if installed) flight,

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

- 3.3.3. Visual and instrument flight conditions,
- 3.3.4. High and low altitudes, and
- 3.3.5. Various weight and balance within aeroplane limitations.

3.4. Emphasis Items

The following items should be emphasized during manoeuvre-based training:

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- 3.4.1. How changes to factors such as weight, G loading, bank angle, altitude and icing affect the handling characteristics and stall speeds of the aeroplane.
- 3.4.2. Abrupt pitch motion may be felt on some aircraft when the autopilot disconnects by itself. This pitch and trim change typically represents an unexpected physical challenge to the pilot when trying to reduce AOA. In some aeroplanes, this may be exacerbated by an additional pitch up when the pilot increases thrust during stall recovery.
- 3.4.3. Stall warnings for the specific aeroplane.
- 3.4.4. Reducing AOA is the proper way to recover from a stall event. Pilots must accept that reducing the aeroplane's AOA may often result in altitude loss. The amount of altitude loss will be affected by the aeroplane's operational environment (e.g., entry altitude, aeroplane weight, density altitude, bank angle, aeroplane configuration, etc.). At high altitudes, stall recovery may require thousands of feet.
- 3.4.5. Noises associated with stick shakers and autopilot disconnect alarms can cause confusion in the cockpit.
- 3.4.6. Understanding that early recognition and return of the aeroplane to a controlled and safe state are the most important factors in surviving stall events (only after recovering to a safe manoeuvring speed and AOA should the pilot focus on establishing an assigned heading, altitude, and airspeed).
- 3.4.7. Differences between high and low altitude stalls; pitch rate and sensitivity of flight controls, thrust available for recovery, and altitude loss.
- 3.4.8. The effects of malfunctioning and/or deferred equipment on stall protection and stick pusher systems.

3.5. Aeroplane-Only Training

If an aeroplane is used during training, it is recommended that full aerodynamic stalls or stall entries causing the activation of the stick pusher be avoided because of potential hazards associated with a stall. Should a stall be inadvertently entered, the recovery inputs from a full stall as specified above should be applied. Any aeroplane stall training should be conducted with due consideration to clearance from terrain and clouds. Aeroplane weight and balance should be within required limits, and a forward centre of gravity position is recommended. Aircraft weight should be limited to ensure adequate performance for recovery from initial indications of a stall.

3.6. Stick Pusher Training

For aeroplanes equipped with a stick pusher, pilots should accomplish theoretical training and practical training in an FFS. It is important for pilots to experience the

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sudden forward movement of the control wheel during a stick pusher activation. From observations, most instructors state that, regardless of previous theoretical 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 manoeuvre.

3.7. 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.

3.7.1. **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.

3.7.2. **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.

4. Other considerations

4.1. 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 aeroplane. Considerable care should be used in startle training to avoid negative learning.

4.2. 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 (SOPs) and CRM for proper avoidance techniques and threat mitigation strategies. Desired training goals for prevention training should include the following:

4.2.1. Proper recognition of operational and environmental conditions that increase the likelihood of a stall event occurring;

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- 4.2.2. Knowledge of basic stall fundamentals, factors that affect stall speed, stall characteristics for the specific aeroplane and any implications for the expected flight operations;
- 4.2.3. 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);
- 4.2.4. Proper recognition of signs of an impending stall so pilots can recognize conditions that can lead to a stall event;
- 4.2.5. The effects of auto-flight and unexpected disconnects of the autopilot and/or auto-throttle; and
- 4.2.6. Proper recognition of when the flight condition has transitioned from the prevention phase and into the recovery phase.

5. Stall recovery template

5.1. Aeroplane commonalities and differences

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

The basic steps were identifying aeroplane 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 aeroplane.

5.2. 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 aeroplanes, manufacturer-recommended procedures may deviate from those included in this SIB due to specific aeroplane 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 aeroplane. Manufacturers are expected to deviate from this template if the aeroplane operating characteristics require.

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

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

This is information only. Recommendations are not mandatory.

TABLE 1. STALL RECOVERY TEMPLATE (WITH ASSOCIATED RATIONALE)

Immediately do the following at first indication of stall (buffet, stick shaker, stick pusher, aural or visual indication) – during any flight phases *except at lift off*.

1	Autopilot and auto-throttle.....Disconnect
Rationale	While maintaining the attitude of the aeroplane, disconnect the autopilot and auto-throttle. 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 auto-throttle 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	ThrustAs 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 aeroplanes with engines installed below the wing, applying maximum thrust may create a strong nose-up pitching moment if airspeed is low. For aeroplanes with engines mounted above the wings, thrust application creates a helpful pitch-down tendency. For propeller-driven aeroplanes, 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 flight-path.
Rationale	Apply gentle action for recovery to avoid secondary stalls then return to desired flight-path.

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APPENDIX 1. SAMPLE DEMONSTRATIONS

1. Two demonstrations were constructed using the philosophies and concepts described in this SIB. 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 aeroplane. 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 SIB.

EXAMPLES OF "DEMONSTRATION FOR STALL TRAINING"

DEMONSTRATION 1	Approach-to-stall recovery with only idle thrust available.
PURPOSE	This <i>demonstration</i> is only intended to show that the aeroplane 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 aeroplane 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 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.
TRAINING OBJECTIVES	The instructor will advise the student that the manoeuvre is complete when the student understands the need to reduce AOA for stall recovery.

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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 aeroplane 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	<ul style="list-style-type: none"> • 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 aeroplane 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 reemphasize all approach-to-stall cues. • Crewmember understanding for aeroplanes 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 aeroplane 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 approach-to-stall indications as they occur. • Upon stick pusher activation, direct the crew to allow the pusher activation and then initiate recovery procedure.
TRAINING OBJECTIVES	<ul style="list-style-type: none"> • The pilot releases back-pressure at pusher activation and allows it to reduce the AOA. • Recovers to the manoeuvring speed appropriate for the aeroplane's configuration without exceeding the aeroplane's limitations. It is probable that some loss of altitude will occur during the recovery. • The manoeuvre is considered complete once a safe speed is achieved and the aeroplane stabilized in level flight.

This is information only. Recommendations are not mandatory.

APPENDIX 2. SAMPLE TRAINING SCENARIOS

Three scenarios were constructed using the philosophies and concepts described in this SIB. They include clean configuration (high altitude), take-off, 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 aeroplane. 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 SIB.
EXAMPLES OF SCENARIOS FOR APPROACH-TO-STALL AND STALL RECOVERY TRAINING**

SCENARIO 1: CLEAN CONFIGURATION APPROACH-TO-STALL (HIGH ALTITUDE)	
INSTRUCTOR ROLE	Implement scenarios that result in an unexpected approach-to-stall near the aeroplane'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	<ul style="list-style-type: none"> • Recognition and recovery. • Crew coordination. • AOA management. • Possible out of trim control forces at autopilot disconnection. • Aural and visual warnings (environment and aeroplane 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, to be addressed AFTER the recovery is affective. • Situational awareness (SA) while returning to desired flight-path after the stall recovery, including such items as heading, altitude, other aircraft, and flight deck automation.
FSTD SETUP CONSIDERATIONS	<p>This scenario will be conducted near maximum operating altitude for the specific aeroplane 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:</p> <ul style="list-style-type: none"> • Airspeed slewing.

This is information only. Recommendations are not mandatory.

	<ul style="list-style-type: none"> • Attitude changes. • Aeroplane weight and centre of gravity (CG) changes. • Environmental changes. • Systems malfunctions (e.g., artificial thrust reduction, surreptitious disabling of automation).
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 manoeuvring flight. • Upon recognising 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, shaker or warning activation (if installed). If stick pusher, shaker or warning activate, it must be allowed to act and then appropriate recovery action should be taken.
TRAINING OBJECTIVES	<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 considerations of altitude loss. • Appropriate application of thrust to accelerate and enable an expeditious recovery. • The return of the aeroplane to safe flight without encountering a secondary stall. • The manoeuvre is considered complete once a safe speed is achieved and the aeroplane stabilized. • Satisfactory crew coordination must be demonstrated.
COMMON ERRORS	<ul style="list-style-type: none"> • Recovery is attempted with thrust instead of reducing AOA. • Under/over control of pitch inputs. • Failure to recognize impending secondary stall. • Reluctance to sacrifice significant altitude. • Increasing the load factor too quickly and getting secondary approach-to-stall cues or stick pusher activation.

This is information only. Recommendations are not mandatory.

SCENARIO 2: TAKE-OFF AND INITIAL CLIMB 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 appropriate stall recovery procedure (at lift off, the procedure may differ) then resume the assigned departure.
EMPHASIS AREAS	<ul style="list-style-type: none"> • Recognition and recovery. • Crew coordination. • AOA management. • Possible out-of-trim control forces at autopilot disconnect (if engaged). • Aural and visual warnings (environment and aeroplane cueing). • Surprise and startle. • Roll instability and buffeting. • Effects of multiple levels of automation. • Effects of altitude on recovery. • SA while returning to desired flight-path 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	<p>The scenario will be conducted during take-off 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:</p> <ul style="list-style-type: none"> • Airspeed slewing, • Attitude changes, • Aeroplane weight and CG changes, • Environmental changes, and • Systems malfunctions (e.g., 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 aeroplane 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.

This is information only. Recommendations are not mandatory.

TRAINING OBJECTIVES	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 aeroplane to safe flight without encountering a secondary stall. The manoeuver is considered complete once the flight reaches and stabilizes at the assigned departure altitude. Satisfactory crew coordination must be demonstrated.
COMMON 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 flight-path or follow ATC instructions after recovery.

This is information only. Recommendations are not mandatory.

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	<ul style="list-style-type: none"> • Recognition and recovery. • Crew coordination. • AOA management. • Possible out-of-trim control forces at autopilot disconnect (if engaged). • Aural and visual warnings (environment and aeroplane cueing). • Surprise and startle. • Roll instability and buffeting. • Effects of multiple levels of automation. • Effects of altitude on recovery. • SA while returning to desired flight-path 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	<p>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:</p> <ul style="list-style-type: none"> • Airspeed slewing, • Attitude changes, • Aeroplane weight and CG changes, • Environmental changes, and • System malfunctions (e.g., artificial thrust reduction, surreptitious disabling of automation).
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 glide-path. • Upon the first indication of a stall, perform the stall recovery procedure • During recovery, the pilot should not allow the aeroplane 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.

This is information only. Recommendations are not mandatory.

TRAINING OBJECTIVES	<ul style="list-style-type: none"> • 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 aeroplane to safe flight without encountering a secondary stall. • The manoeuvre is considered complete when safe speed has been achieved and the pilot initiates the missed approach. • Satisfactory crew coordination must be demonstrated.
COMMON 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 AOA reduction. • Failure to roll wings level to improve performance. • Losing SA and failing to return to assigned flight-path and complete a missed approach, or follow ATC instructions after recovery.

This is information only. Recommendations are not mandatory.

APPENDIX 3. FSTD CONSIDERATIONS

1. **SUMMARY OF SIMULATOR CAPABILITIES.** FSTDs which replicate transport category aeroplanes and are appropriately qualified by EASA can be reliably used for training to the first indication of a stall, which includes angles of attack up to the stall warning.
 - 1.1. **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 manoeuvres (such as verification of stall warning speeds, stall buffet speeds, etc.).
 - 1.2. **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 aeroplane.
 - 1.3. **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 aeroplane). EASA does not recommend post-stall training with the current generation of FSTD because they can't reproduce the aeroplane behaviour in these post-stall conditions. When FSTD fidelity will be improved in post-stall conditions, it will be possible to review this position.

2. **BACKGROUND INFORMATION.** During the development of this SIB, 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:
 - 2.1. To date, flight training requirements are limited to approach-to-stall manoeuvres as opposed to full stall manoeuvres. 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. Also, by design, the buffet in the simulator is not adjusted as a function of the Mach. Nevertheless, the fact that the angle of attack buffeting value is not correct does not much affect the training as the target is to teach the recovery when the buffeting appears, whatever is the AoA.
 - 2.2. 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.
 - 2.3. 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.

This is information only. Recommendations are not mandatory.

- 2.4. **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.
- 2.5. **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 behaviour 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 manoeuvre.
3. **FSTD EVALUATION RECOMMENDATIONS.** While changes to the FSTD qualification standards are currently being developed, they are outside the scope of this SIB. It is highly recommended that all FSTDs being used for approach-to-stall training manoeuvres are specifically evaluated for such manoeuvres. 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 manoeuvres:
- 3.1. **Approach-to-Stall Training Manoeuvres.**
To ensure a high level of FSTD fidelity, training manoeuvres 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. For approach-to-stall training manoeuvres that are not objectively evaluated for FSTD qualification (such as cruise/high altitude approaches to stall and turning flight approaches to stall), additional objective and subjective evaluations should be conducted to determine adequate FSTD fidelity. This additional evaluation should include:
- Objective evaluation of stall warning and stall buffet speed against published aircraft data (such as AFM stall tables).
 - Subjective evaluation by a SME pilot that is experienced in the approach to stall characteristics of the aircraft.
- 3.2. **Stick Pusher Demonstration Manoeuvres.**
The stick pusher activation speeds (or associated angles of attack) should be objectively evaluated against published aircraft data (such as the AFM stall tables).
The modelling 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.

This is information only. Recommendations are not mandatory.

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.

Since a stick pusher demonstration manoeuvre 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.

This is information only. Recommendations are not mandatory.