CIVIL AVIATION AUTHORITY OF VIET NAM

ADVISORY CIRCULAR
AC 14-003

UPSET PREVENTION AND RECOVERY TRAINING

SECTION 1 GENERAL

1.1 PURPOSE

This advisory circular (AC) describes the recommended training for airplane Upset Prevention and Recovery Training (UPRT). The goal of this AC is to provide recommended practices and guidance for academic and flight simulation training device (FSTD) training for pilots to prevent developing upset conditions and ensure correct recovery responses to upsets.

This advisory circular (AC) describes the recommended training for airplane Upset Prevention and Recovery Training (UPRT). The goal of this AC is to provide recommended practices and guidance for academic and flight simulation training device (FSTD) training for pilots to prevent developing upset conditions and ensure correct recovery responses to upsets. The AC was created from recommended practices developed by major airplane manufacturers, labor organizations, air carriers, training organizations, simulator manufacturers, and industry representative organizations. This AC provides guidance to VAR Part 14 AOC Personnel Qualification implementing the regulatory requirements of part 14, §14.071. Although this AC is directed to AOC holder to implement Part 14 regulations, the CIVIL AVIATION AUTHORITY OF VIETNAM - CAAV encourages all airplane operators, pilot schools, and training centers to implement UPRT and to use this guidance, as applicable to the type of airplane in which training is conducted.

1.2 STATUS OF THIS ADVISORY CIRCULAR

This is an original issuance of this AC.

1.3 BACKGROUND

Operational data indicates that some pilots have failed to prevent airplanes from entering a fully developed upset and have not been able to properly recover from such events. In addition to stall training, Upset Prevention and Recovery Training (UPRT) is an essential training element to reduce loss of control events or, if they occur, enable recovery to normal flight.

1.4 APPLICABILITY

Although the training in this AC is designed to be conducted in an 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 UPRT in airplanes. The CAAV recommends that any operator conducting UPRT in airplanes follow the guidance and associated risk mitigation strategies contained in ICAO's Doc 10011, Manual on Aeroplane Upset Prevention and Recovery Training.

1.5 RELATED REGULATIONS

The following regulations are directly applicable to the guidance contained in this advisory circular

- VAR Part 7, Aviation Personnel License ;
- VAR Part 14, AOC Personnel Qualification.

1.6 RELATED PUBLICATIONS

For further information on this topic, individuals, instructors and examiners are invited to consult the following publications—

1) International Civil Aviation Organization (ICAO)

- ICAO Annex 1- Personnel Licensing;
- ICAO Annex 6- Operations of Aircraft, Parts 1;
- ICAO Annex 19 – Safety Management;
- ICAO's Doc 10011, Manual on Aeroplane Upset Prevention and Recovery Training.
- ICAO's Doc 9379 Manual of Procedures for Establishment and Management of a State's Personnel Licensing System;
- ICAO's Doc 9625 Manual of Criteria for the Qualification of Flight Simulation Training Devices, Volume I - Aeroplanes;
- ICAO's Doc 9859 Safety Management Manual (SMM);
- ICAO's Doc 9995 Manual of Evidenced-Based Training.

2) CAAV Guidance

- AC 07-013 Airline Transport Pilot and Aircraft Type Rating Practical Test Standards for Airplane.
- AC 07-011,12 Commercial Pilot Practical Test Standards for Airplane (Single-Engine Land (SEL), Multiengine Land (MEL), Single-Engine Sea (SES), Multiengine Sea (MES)).

- AC 14-001 Training Curriculums;
- AC 07-004 FTSD Approvals.

3) Other publication

- Airplane Upset Recovery Training Aid (AURTA) = Revision 3 (by an industry and government working group) or any future revision (references to sections of the AURTA are to Revision 3);
- FAA Advisory Circular, AC 120-111 Upset Prevention and Recovery Training;
- EASA Annex II to ED Decision 2015-012-R EASA UPRT.

1.7 DEFINITIONS & ACRONYMS

a. Academic training. Training that places an emphasis on studying and reasoning designed to enhance knowledge levels of a particular subject, rather than to develop specific technical or practical skills.

b. Aerodynamic stall. An aerodynamic loss of lift caused by exceeding the critical angle of attack (synonymous with the term "stall").

c. Airplane Upset. An airplane in flight unintentionally exceeding the parameters normally experienced in line operations or training:

- Pitch attitude greater than 25 degrees nose up;
- Pitch attitude greater than 10 degrees nose down;
- Bank angle greater than 45 degrees; or
- Within the above parameters, but flying at airspeeds inappropriate for the conditions.

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

e. Awareness. Knowledge or perception of the situation.

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

g. Developing Upset Condition. Any time the airplane is diverging from the intended flightpath and has not yet exceeded the parameters defining airplane upset.

h. Distraction. The diversion of attention away from the primary task of flying.

i. Extended Envelope Training. The flight training consisting of:

- Manually controlled slow flight;
- Manually controlled loss of reliable airspeed;
- Manually controlled instrument departure and arrival;

- Upset recovery maneuvers;
- Recovery from bounced landing; and
- Instructor-guided hands on experience of recovery from full stall and stick pusher activation.

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

k. Flightpath Management. Active manipulation, using either onboard avionics systems or manual handling, to command the aircraft flight controls to direct the aircraft along a desired trajectory in the lateral and vertical planes.

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

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

n. Loss of Control in Flight (LOC-I). A categorization of an accident or incident resulting from a deviation from the intended flightpath.

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

p. Prevention. Actions to avoid any divergence from a desired airplane state.

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

r. 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.

s. Surprise. An unexpected event that violates a pilot's expectations and can affect the mental processes used to respond to the event.

t. Transfer of Training. The ability of a trainee to apply knowledge, skills, and behavior acquired in one learning environment (e.g., a classroom, an FSTD) to another environment (e.g., flight). In this context, "negative transfer of training" refers to the inappropriate generalization of knowledge or skills learned in training to line operations.

u. Undesired Aircraft State. A position, velocity, or attitude of an aircraft that reduces or eliminates safety margins.

SECTION 2. UPSET PREVENTION AND RECOVERY TRAINING (UPRT) PRINCIPLES

2.1. GENERAL.

An effective UPRT curriculum provides pilots with the knowledge and skills to prevent an upset, or if not prevented, to recover from an upset. Training should focus on preventing upsets rather than waiting to recover from one. The focus on prevention is a significant shift from previous upset or unusual attitude training, which primarily focused on recovering from a fully developed upset. Prevention training prepares pilots to avoid incidents, while recovery training intends to avoid an accident if an upset occurs.

2.2. TRAINING PHILOSOPHY.

While basic aerodynamics and unusual attitude[1] training are required elements for a pilot's private, commercial, and airline transport pilot (ATP) certifications, it is important to reinforce and expand upon this certification training throughout a pilot's career. This advisory circular (AC) describes the academic and flight training components of a comprehensive UPRT curriculum, requirements for UPRT instructors, flight simulation training device (FSTD) requirements, upset recovery procedures, and sample UPRT scenarios.

a. Training Goal. A pilot who has successfully completed UPRT will demonstrate knowledge and skill in preventing, recognizing, and, if necessary, recovering from an upset.

b. Training Methodology. UPRT is to be conducted as train-to-proficiency (i.e., training will continue until completion criteria are met).

NOTE: UPRT is not to be evaluated in proficiency checks, line-oriented evaluation (LOE), or by other jeopardy events.

c. Completion Criteria for Prevention. Prevention is the primary goal of UPRT, including timely action to avoid progression toward a potential upset.

- When acting as either pilot flying (PF) or pilot monitoring (PM), actively scans the internal and external environment and identifies and alerts the crew to factors that may lead to divergence from the desired flightpath.
- When acting as PM, creates, communicates, and manages alternative courses of action that reduce the likelihood of an upset.

d. Completion Criteria for Recognition. Timely action to recognize divergence from the intended flightpath and interrupt progression toward a potential upset.

- When acting as PF, prompt recognition of divergence from intended flightpath or uncommanded changes to the aircraft flightpath.
- When acting as PM, active monitoring of aircraft state and flight parameters and prompt callout of divergence from planned or briefed flightpath.
- Take prompt action (if PF or through callouts if PM) to correct a divergence from

the intended flightpath and interrupt progression toward a potential upset.

e. Completion Criteria for Recovery. Timely action to recover from an upset in accordance with the air carrier's procedures, or in the absence thereof, in accordance with recommendations provided in Section 4 of this AC.

- A PF will take action, or a PM will call out the need, for timely execution of recovery priorities: 1) manage the energy; 2) arrest flightpath divergence; 3) recover to stabilized flightpath.
- Apply (PF), or monitor (PM), appropriate control actions to recover the aircraft without exceeding aircraft limitations.
- When an upset is precipitated by stall, recover from the stall before initiating other recovery actions.

2.3. IMPORTANCE OF THE UPRT INSTRUCTOR.

The key to effective UPRT is the instructor. The safety implications and consequences of applying poor instructional technique, or providing misleading information, are more significant in UPRT compared with some other areas of pilot training. Therefore, an essential component in the effective delivery of UPRT is a properly trained and qualified instructor who possesses sound academic and operational knowledge.

2.4. INSTRUCTOR REQUIREMENTS (§14.130 & §14.133)

UPRT instructors must meet the following requirements:

- Hold an ATP Certificate and airplane type rating[2] in the airplane for which they are conducting training.
- Successfully complete the certificate holder's UPRT program as a student and the UPRT instructor training in paragraph 2.5 below.
- Be able to teach, assess, and debrief the elements included in the training programs they are conducting.
- Be trained and qualified to conduct training in the FSTD to be used for the training.

2.5. INSTRUCTOR TRAINING.

Instructor knowledge of the subject areas below ensures accurate UPRT and minimizes the risk of negative transfer of training. The focus of instructor training should be on the practical application of these principles and the evaluation of a pilot's understanding of the airplane's operating characteristics. Instructor training should include the following and if a regulation is cited, the training is required:

a. Limitations of the FSTD.

(1) Instructors must complete training on the data and motion limitations for each specific FSTD used for UPRT with emphasis on areas that have the potential to introduce negative transfer of training. Training on the limitations of the specific FSTD will enable instructors to provide upset recovery training consistent with the capabilities and performance of the specific aircraft type. This comprehensive instructor training will not only increase instructor standardization and the quality of upset recovery training, but it will also reduce the risk of negative training that could easily occur with an untrained instructor.

(2) Instructors should learn to brief and debrief pilots on these limitations.

(3) Negative transfer of training has previously occurred as a result of the instructor's lack of knowledge of the limitations of the FSTD. FSTD instructors must be aware that valid training may be limited to the parameters to which the FSTD has been programmed and evaluated to conduct. Operating outside of these parameters may result in the FSTD responding differently than the airplane would to a pilot's control inputs. Motion cueing information may not always accurately simulate the associated forces and rates that could be felt in an airplane.

(4) Instructors must have a clear understanding of the FSTD limitations that may influence UPRT, including:

- The FSTD's acceptable training envelope;
- G loading awareness/accelerated stall—factors absent from the FSTD's motion cueing that could be experienced in flight and the effect on airplane behavior and recovery considerations; and
- Significant deviations from the FSTD's validation envelope could result in an inaccurate FSTD response. While minor excursions from the FSTD's validation envelope may not necessarily invalidate the training, instructors should be aware that the airplane's response in an actual upset condition may deviate from what is experienced in the FSTD. Particular upset scenarios should be selected and evaluated before training takes place to reduce the likelihood of significant excursions outside of the FSTD's validation envelope.

(5) Refer to Appendix 3-D, Flight Simulator Information, of the Airplane Upset Recovery Training Aid (AURTA) Revision 3 for more information.

b. Simulator Instructor. Instructors must complete training on the proper operation of the controls, systems, and environmental and fault panels for each specific FSTD used for UPRT. This includes the specific SI indications and controls that will be used to provide training and feedback during UPRT events.

c. Minimum FSTD Equipment. Instructors must complete training on the minimum FSTD equipment required by VAR Parts 7 and 14 for each UPRT event. Instructors must understand that UPRT must only be conducted if the minimum FSTD equipment is functional; otherwise, negative transfer of training could occur.

d. Review of Loss of Control In-Flight (LOC-I) Events, Incidents, and Accidents. Training and review of LOC-I events, incidents, and accidents increases knowledge and skill development to recognize and to recover from an airplane upset. A review of LOC-I events will provide pilots with a focus and a context for the consequences of allowing the airplane to develop into an upset.

e. Energy Management.

(1) It is important that instructors not only understand energy management but also be able to apply it as a means of upset prevention. UPRT instructors should be trained on specific techniques and maneuvers to demonstrate and train energy management principles effectively.

(2) An improper understanding of airplane energy state has contributed to a pilot's poor understanding of airplane control. This poor understanding influenced the previous improper training of stall recovery. It is therefore important that instructors understand how energy management is a factor in all phases of flight, as well as in UPRT.

f. Spatial Disorientation. Instructors should be trained in a variety of causes of disorientation, prevention strategies, recognition cues, and recovery from disorientation, because spatial disorientation training may not be effectively represented in an FSTD.

g. Distraction. UPRT instructors should have an awareness of how distractions can lead to an airplane upset and how to effectively use distractions in training. Appropriate use of distractions can also assist the instructor in creating a situation to induce startle. UPRT instructors should learn about different distractions that can affect a flight crew, such as:

- Communication,
- Heads-down work,
- Responding to abnormal/unexpected events,
- Searching for traffic,
- Flight deck ergonomics,
- Flight deck noise level,
- English language proficiency (from both the pilots and air traffic control (ATC)),
- Airport infrastructure, and
- Flight crew fatigue.

h. Recognition and Recovery Strategies. Instructors should be able to convey how to recognize upset conditions and to apply appropriate recovery strategies. Training should include specific examples, in both academic discussion and practical demonstration.

i. Recognition and Correction of Pilot Errors. Errors may occur in flight operations if the errors are not identified and corrected during training. Instructors should be aware of the consequences of failing to recognize and correct pilot errors. Instructors should be familiar with common pilot errors, be able to identify the root cause, and provide training to avoid errors and incorrect inputs that can create undesired aircraft states (such as over controlling for Traffic Alert and Collision Avoidance System (TCAS) Resolution Advisories).

j. Type-Specific Characteristics. Original Equipment Manufacturers (OEM) have recognized that different airplanes have unique characteristics that may both assist in, or deter from, the recognition and recovery of an airplane upset. UPRT instructors should know specific unique characteristics regarding airplane handling and recognition, such as how the airplane responds while approaching stall buffet or the effects of envelope protection.

k. OEM-Specific Recommendations. Evidence indicates that training programs using operating procedures from one airplane type may have a detrimental effect if carried over to a different airplane type. This can lead to an upset. Training should use airplane-specific OEM recommendations and air carrier procedures developed from OEM recommendations for prevention and recovery from an upset.

l. Operating Environment. Current training does not always take into consideration the different handling characteristics in all areas of the operating envelope. Instructors should be trained in how to demonstrate the effects of the operating environment, as well as how these will affect the airplane handling characteristics and potentially lead to an airplane upset. This should include how changes in the environmental conditions will affect the airplane. An example is showing how thrust available varies significantly with altitude by timing how long it takes to change speed by 25 knots during level flight at low and high altitude.

m. Startle or Surprise. Because upsets that occur in normal flight operations are unplanned and inadvertent, pilots may be startled or surprised, adversely impacting recognition or recovery. Instructors need to plan scenarios to balance potential for startle or surprise while applying sound judgment with respect to realism and fidelity, and respecting the capabilities and limitations of the FSTD. It is crucial for the instructor to adopt and foster a spirit of collaborative learning when inducing startle or surprise so as not to inappropriately attempt to trap a pilot or destroy confidence in the training session.

n. Benefits of Demonstration in an FSTD. Some elements of UPRT may be more assessable, trainable, and effective when FSTD instructors demonstrate them from a pilot seat.

o. Assessing Pilot Performance to Completion Standards. Instructors should be able to assess when an appropriate level of proficiency is achieved. Instructors should be trained on how to judge pilot performance on the UPRT events and determine whether the required learning objectives have been met.

2.6. INSTRUCTOR STANDARDIZATION.

a. Initial Standardization Validation. Following completion of UPRT instructor training, and before providing unsupervised instruction, instructors should complete an Instructor Standardization validation to ensure readiness to provide accurate UPRT, to include evaluation of:

- UPRT knowledge and skills applicable to the UPRT for which they are being standardized.
- Ability to teach, brief, assess, and debrief the elements included in the UPRT for which they are being standardized.
- FSTD instructor ability to effectively operate the device and all of its available debriefing capabilities.
- Effective recognition of pilot errors, identification of root cause, and adjustments to training to correct errors and achieve the required level of proficiency.
- Assess the achievement of an appropriate level of proficiency in accordance with the completion criteria.

b. Continuing Standardization. Each air carrier should have a control system in place to ensure its instructors continuously deliver standardized UPRT. Instructors who do not follow the curriculum may provide pilots with negative training.

SECTION 3. TRAINING METHODOLOGY

3.1. GENERAL.

The training methodology for UPRT should follow the building block approach of first introducing essential concepts and academic understanding before progressing to the practical application of those skills in a flight simulation training device (FSTD).

Similarly, familiarity with airplane characteristics and development of basic recovery skills through maneuver-based training should precede their application in scenario-based training. This progressive approach will lead to a more complete appreciation of how to recognize a developing flightpath divergence, respond appropriately in situations of surprise or startle, and recover effectively when required. Air carriers should develop training curriculums that provide pilots with the knowledge and skills to prevent, recognize, and recover from unexpected flightpath divergences and upset events. These training curriculums should contain the elements and events described in Appendix 1.

3.2. COMPREHENSIVE AOC UPRT PROGRAM.

a. General. The CAAV strongly recommends incorporation of the Airplane Upset Recovery Training Aid (AURTA) Revision 3 into air carrier UPRT programs. The AURTA Revision 3 has extensive discussion and considerations for both the academic and flight training portion of an air carrier's training program. The AURTA Revision 3 is available online at

b. Academic Knowledge. Academic instruction establishes the foundation from which situational awareness, insight, knowledge, and skills are developed, and therefore must be accomplished prior to training the associated flight events in an FSTD. To ensure sufficient retention, FSTD training should occur within a reasonable time after academic training. Academic knowledge should proceed from the general to the specific.

c. FSTD Training. §14.155 requires simulation training device for AOC holder training is approved by CAAV, which consists of the following maneuvers to be conducted in a Level C or higher full flight simulator (FFS): manually controlled slow flight, manually controlled loss of reliable airspeed, manually controlled instrument departure and arrival, and upset recovery maneuvers. Other flight training that is part of UPRT, but not required by regulation to be conducted in an FFS may be conducted in another type of FSTD; however, the FSTD should have the level of fidelity required to meet the learning objective. Training providers are encouraged to use the highest level FFS available when developing their UPRT curriculums. The primary emphasis is to provide the pilot with the most realistic environment possible during UPRT. Motion in an FFS should be used when those cues influence recognition or recovery.

(1) FSTD flight training should follow a logical progression where pilots are introduced to the airplane's capabilities within the operating limits prior to training at the edge of the normal flight envelope, or beyond. While exceeding the normal flight envelope in an FFS is possible, all UPRT maneuvers contained in this AC can typically be conducted inside the FFS's intended training envelope where the performance and handling qualities of the FFS are at their highest accuracy. Training that exceeds the airplane envelope or the aerodynamic modeling envelope could increase the risk of negative transfer of training. Significant sustained accelerations and rates are not possible in an FFS, and instructors should be able to explain to pilots how the actual aircraft behavior may differ. See Appendix 3 for detailed FSTD considerations.

(2) FSTD training should include both maneuver-based and scenario-based training. Air carriers are encouraged to consult with the airplane manufacturer during the development of the FSTD training.

(a) Maneuver-Based Training. This training focuses on task mastery. Maneuver-based training should include prevention and recovery training with an emphasis on the development of required motor skills to satisfactorily accomplish upset recovery. Limited emphasis should be placed on decision-making skills during maneuver-based training.

(b) Scenario-Based Training (SBT). The goal of SBT is to develop perception and decision-making skills relating to upset prevention, recognition, and recovery, while providing the pilot with an opportunity to use the skills learned in maneuver-based training in a realistic scenario. SBT would normally be used after maneuver-based training, during the later stages of an initial, transition, or upgrade training curriculum, and during recurrent training.

1. **Realistic Scenarios.** UPRT scenarios should be realistic events that could be encountered in operational conditions. When possible, scenarios should include accident, incident, Aviation Safety Action Program (ASAP), Flight Operational Quality Assurance (FOQA), and/or Aviation Safety Reporting System (ASRS) data to convey how threat situations may develop and how they should be managed. Sample SBT lesson plans are provided in Appendix 2.

2. **Briefing.** Pilots should not normally be briefed that they are receiving SBT. The concept allows pilots to recognize and manage upset threats as they develop during normal operations.

3.3. KEY UPRT CONSIDERATIONS.

a. Awareness and Prevention. Training with an emphasis on awareness and prevention provides pilots with the skills to recognize conditions that increase the likelihood of an upset event if not effectively managed. Training must include the air carrier’s standard operating procedures (SOP) and Crew Resource Management (CRM) techniques for the most effective prevention and threat mitigation strategies. Desired goals for awareness and prevention training include the following:

(1) Recognition of operational and environmental conditions that increase the likelihood of an upset event occurring;

(2) Aeronautical decision-making skills to prevent upsets (e.g., effective analysis, awareness, resource management, mitigation strategies, and breaking the error chain through airmanship and sound judgment);

(3) Early detection of flightpath divergences;

(4) Timely and appropriate intervention;

(5) The effects of autoflight including mode confusion, flight envelope protection in normal and degraded modes, and unexpected disconnects of the autopilot or autothrottle/autothrust;

(6) Recognition of when the flight condition has transitioned from the prevention phase into the recovery phase; and

(7) Effective verbal and nonverbal communication regarding the airplane state.

b. Manual Flight Operations Knowledge, Skills, and Utilization. Modern aircraft are commonly operated using autoflight systems (e.g., autopilot or autothrottle/autothrust) during most of a flight. Autoflight systems have improved safety, reduced workload, and enabled more precise operations; however, continuous use of autoflight systems could lead to degradation of the pilot's manual handling skills and ability to recover the aircraft from an upset.

NOTE: Operator are encouraged to take an integrated approach by incorporating manual flight operations into both line operations and training (initial, transition, upgrade, requalification, and recurrent).

(1) Training. Several maneuvers are included in Appendix 1 specifically to develop and maintain a pilot's manual flight operations knowledge and skills.

(2) Operations. Air carriers should develop policies that encourage manual flight operations when appropriate. Operational policies should be developed or reviewed to ensure there are appropriate opportunities for pilots to exercise manual flying skills, such as in non-Reduced Vertical Separation Minimum (RVSM) airspace and during low workload conditions. In addition, policies should be developed or reviewed to ensure that pilots understand when to use the automated systems, such as during high workload conditions or for airspace procedures that require precise operations. Augmented crew operations may also limit the ability of some pilots to obtain practice in manual flight operations. Airline operational policies should ensure that all pilots have the appropriate opportunities to exercise manual flight knowledge and skills in flight operations.

(3) Use of Autopilot and/or Autothrottle/Autothrust for Upset Recovery. 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.

c. Availability of Visual References. The CAST study of 18 accidents and incidents resulting from pilot loss of airplane state awareness determined that 17 accidents and incidents occurred when pilots did not have visual references available (i.e., instrument meteorological conditions (IMC) or night). In the past, unusual attitude training was commonly conducted in visual meteorological conditions, giving the pilot considerable advantage in determining the appropriate recovery. To develop a pilot's ability to recover from an upset, FSTD maneuvers training should be done in both visual and instrument conditions, as well as in day and night. This allows pilots to practice recognition and recovery under all conditions in order to experience important physiological factors.

d. Pilot Monitoring. Evidence shows that in many loss of control in-flight (LOC-I) incidents and accidents the pilot(s) monitoring (PM) may have been more aware of the airplane state than the pilot flying (PF). Training should emphasize crew interaction (including augmented flight crews) to vocalize a divergence from the intended flightpath. A progressive intervention strategy is initiated by communicating a flightpath deviation (alert), then suggesting a course of action (advocacy and assertion), and then directly intervening, if necessary, by taking the controls to prevent an incident or accident. A pilot taking control should announce the transfer of control.

e. Startle or Surprise. Startle or surprise has been a factor in LOC-I incidents and accidents as upsets that occur in normal operations are unplanned and inadvertent, adversely impacting recognition or recovery. Instructors should plan upset scenarios emphasizing those event conditions and variables likely to result in startle/surprise while minimizing potential for negative transfer of training. The potential for negative transfer of training can be minimized through applying sound judgment with respect to realism and fidelity, as well as respecting the capabilities and limitations of the FSTD. The following points should be considered:

- Many possible events should be available for use during training. Otherwise, pilots will anticipate the event and not be surprised.
- The events should be taught in a supportive learning environment without jeopardy. Otherwise, incentives are introduced for pilots to share with other pilots what to expect.
- Even if incentives are not introduced, pilots should be discouraged from revealing information about the events to other pilots that have yet to experience them. Divulging a surprise scenario removes the benefit of allowing a colleague to examine his or her thoughts and responses in critical situations that arise in training. As such, the strategic objective of inserting these scenarios in training should be emphasized for the benefit of all.
- Instructors will have to be inventive and introduce various ploys to achieve a startle or surprise response in simulation. Managing expectations in this way can help achieve responses while surprised even in simulation environments when the fear of harm does not exist.

SECTION 4. UPSET RECOVERY TEMPLATE

4.1. METHODOLOGY.

Airplane manufacturers (Airbus, ATR Aircraft, Boeing, Bombardier, and Embraer) contributed to the development of the following upset recovery templates that provide commonality among various airplanes.

4-2. UPSET RECOVERY TEMPLATES.

Tables 1 and 2 show the Nose High and Nose Low Upset Recovery Templates that were developed with input from the above manufacturers.

Although the procedures apply to the majority of today's airplanes, manufacturer-recommended procedures may deviate from those included in this advisory circular (AC) due to specific airplane characteristics. Manufacturer recommendations may deviate from this template if necessary due to airplane operating characteristics. For air carriers operating airplanes without manufacturer upset recovery procedures, the CAAV recommends using the upset recovery templates as a reference when developing air carrier-specific upset recovery procedures.

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

NOTE: These techniques assume the airplane is not stalled. If the airplane is stalled, recovery from the stall must be accomplished in Stall Prevention and Recovery Training, or manufacturer procedures.

a. The following techniques represent a logical progression for recovering the airplane. While not strictly procedural, the templates represent a consensus view of actions for recovery.

b. If needed, use pitch trim sparingly. Careful use of rudder to aid roll control should be considered only if roll control is ineffective.

c. This section uses the following acronyms: AP for autopilot and A/THR for autothrottle / autothrust.

TABLE 1. NOSE HIGH RECOVERY TEMPLATE

Either Pilot: Recognize and confirm the developing situation. Announce: "Nose High"	
Pilot Flying	**Pilot Monitoring**
AP: DISCONNECT[3]	MONITOR airspeed and attitude throughout the recovery and ANNOUNCE any continued divergence.
A/THR: OFF	
PITCH: Apply as much nose-down control input as required to obtain a nose-down pitch rate.	
THRUST: Adjust (if required)	
When airspeed is sufficiently increasing: RECOVER to level flight[4]	

NOTE: Recovery to level flight may require use of pitch trim.

NOTE: If necessary, consider reducing thrust in airplanes with underwing-mounted engines to aid in achieving nose-down pitch rate.

WARNING: Excessive use of pitch trim or rudder may aggravate the upset situation or may result in high structural loads.

[3] A large out-of-trim condition could be encountered when the AP is disconnected.
[4] Avoid stall because of premature recovery or excessive G loading.

TABLE 2. NOSE LOW RECOVERY TEMPLATE

Either Pilot: Recognize and confirm the developing situation. Announce: "Nose Low"	
Pilot Flying	**Pilot Monitoring**
AP: DISCONNECT[5]	MONITOR airspeed and attitude throughout the recovery and ANNOUNCE any continued divergence.
A/THR: OFF	
RECOVER from stall if required	
ROLL[6] in the shortest direction to wings level.	
THRUST and DRAG: Adjust (if required)	
RECOVER to level flight[7]	

NOTE: Recovery to level flight may require use of pitch trim.

WARNING: Excessive use of pitch trim or rudder may aggravate the upset situation or may result in high structural loads.

[5] A large out-of-trim condition could be encountered when the AP is disconnected.
[6] It may be necessary to reduce the G loading by applying forward control pressure to improve roll effectiveness.
[7] Avoid stall because of premature recovery or excessive G loading.

TABLE 3. NOSE HIGH RECOVERY TEMPLATE WITH EXPLANATION

Either Pilot: Recognize and confirm the developing situation. Announce: “Nose High”
Explanation: A critical element in recognition and confirmation is to clearly understand the energy state and the rate to which it is changing because this will have an effect on how the PF handles the recovery.
Pilot Flying
AP: DISCONNECT[8]
A/THR: OFF
Explanation: 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.
PITCH: Apply as much nose-down control input as required to obtain a nose-down pitch rate.
Explanation: This may require as much as full nose-down input. If a sustained column force is required to obtain the desired response, use nose-down trim as needed to counter high stick forces. If nose-down inputs are not successful in achieving a nose-down pitch rate, pitch may be controlled by rolling the airplane. A large bank angle is helpful in reducing excessively high pitch attitudes. The angle of bank should not normally exceed approximately 60°. Continuous nose-down elevator pressure will keep the wing angle of attack low, which will make the normal roll controls effective. The rolling maneuver changes the pitch rate into a turning maneuver, allowing the pitch to decrease.
THRUST: Adjust (if required)
Explanation: Combined with pitch trim, an additional effective method for achieving a nose-down pitch rate on airplanes with under-wing-mounted engines can be to reduce the power. Thrust should only be reduced to the point where control of the pitch is achieved. This reduces the upward pitch moment. In fact, in some situations for some airplane models, it may be necessary to reduce thrust to prevent the angle of attack from continuing to increase. If the pitch rate is being managed by trim and elevator inputs, it is not recommended to reduce thrust.

[8] A large out-of-trim condition could be encountered when the AP is disconnected.

TABLE 3. NOSE HIGH RECOVERY TEMPLATE WITH EXPLANATION (CONTINUED)

RECOVER to level flight[9] when airspeed is sufficiently increasing:
Explanation: Recover to slightly nose-low attitude to reduce the potential for entering another upset. Roll to wings level, if necessary, as the nose approaches the horizon. Check airspeed, and adjust thrust and pitch as necessary.
Pilot Monitoring
MONITOR airspeed and attitude throughout the recovery and ANNOUNCE any continued divergence.
Explanation: Evidence shows that the PM is often in a better position than the PF to recognize adverse trends in airplane state or flight parameters.

TABLE 4. NOSE LOW RECOVERY TEMPLATE WITH EXPLANATION

Either Pilot: Recognize and confirm the developing situation. Announce: "Nose Low"
Explanation: A critical element in recognition and confirmation is to clearly understand the energy state and the rate to which it is changing because this will have an effect on how the PF handles the recovery.
Pilot Flying
AP: DISCONNECT[10]
A/THR: OFF
Explanation: 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.
RECOVER from stall if required
Explanation: Even in a nose-low, low-speed situation, the airplane may be stalled at a relatively low pitch. It is necessary to recover from the stall first. This may require nose-down elevator, which may not be intuitive.
ROLL[11] in the shortest direction to wings level.
Explanation: Full aileron and spoiler input may be necessary to smoothly establish a recovery roll rate toward the nearest horizon. It is important that positive G force not be increased or that nose-up elevator or stabilizer trim be used until the airplane approaches wings level. It may be necessary to unload the airplane by decreasing backpressure to improve roll effectiveness. If the airplane has exceeded 90° of bank, it may feel like "pushing" in order to unload. It is necessary to unload to improve roll control and to prevent pointing a large lift vector towards the ground.
THRUST and DRAG: Adjust (if required)
Explanation: If airspeed is low, apply thrust; if airspeed is high, reduce thrust, and if necessary, extend speedbrakes.
RECOVER to level flight[12]
Explanation: Complete the recovery by establishing a pitch, thrust, and airplane drag device configuration that corresponds to the desired airspeed.

[10] A large out-of-trim condition could be encountered when the AP is disconnected.
[11] It may be necessary to reduce the G loading by applying forward control pressure to improve roll effectiveness.
[12] Avoid stall because of premature recovery or excessive G loading

TABLE 4. NOSE LOW RECOVERY TEMPLATE WITH EXPLANATION (CONTINUED)

Pilot Monitoring
MONITOR airspeed and attitude throughout the recovery and ANNOUNCE any continued divergence.
Explanation: Evidence shows that the PM is often in a better position to recognize adverse trends in airplane state or flight parameters than the PF.

NOTE: Recovery to level flight may require use of pitch trim.

WARNING: Excessive use of pitch trim or rudder may aggravate the upset situation or may result in high structural loads.

APPENDIX 1. TRAINING ELEMENTS AND EVENTS

1. Aerodynamics	
Academic	**a. General Aerodynamics:** • Aerodynamic flight envelope. • Load factor. • Directional and lateral control. • Weight and balance effects on handling. • Trim. • Sideslip. **b. Advanced Aerodynamics:** • Lift versus drag (L/D) curve, L/D Max in particular, and significance on airplane performance in general. • Relationship between L/D curve and airspeed. • Airplane energy state and its application in various flight altitudes, airspeeds, and attitudes. • Optimum climb speed, crossover altitude, optimum altitude, and maximum altitude as they relate to airplane performance and the effect of deviations (environmental or airplane) on performance. • Thrust required versus thrust available. • Thrust-limited conditions and recovery. • Aerodynamic stability and its effects in flight including maneuvering stability and characteristics at high and low altitude; environmental impact on aerodynamics and handling (e.g., temperature, ice, etc.). **c. Airplane Performance (high and low altitude):** • Use of airplane (type-specific) performance charts to determine the effects of environmental, airplane configuration, or system changes on planned flight performance. • Training pilots to understand that an airplane may not be able to reach its maximum certified altitude depending on performance at the time of the flight is critical. Pilots should also understand the possible consequences of choosing a cruising altitude that exceeds the airplane's performance capabilities for the conditions existing at the time of the flight. • Recognition of the different flight deck cues between low-speed buffet and high-speed buffet.

	d. Type-specific aerodynamics: • Angle of Attack (AOA) awareness including: • Importance of AOA as it relates to airplane performance and wing stall angle. • Effect of airplane configuration (e.g., flaps, gear, leading edge slats, speed brakes, and thrust/power setting) on stall margins and stall characteristics. • AOA relationship to various airplane systems, particularly warning systems (e.g., stall warning, stick shaker, stick pusher, etc.). • General and airplane-specific AOA knowledge. • Impact of environmental and system factors on AOA indications and their relationship to the stall AOA and various airplane warning systems (e.g., type-specific knowledge of the stall warning system). • AOA indications, if presented to the pilot. • Airplane-specific handling to use AOA-derived information to prevent or recover from an upset (including stall). **e. Mach effects including:** • Mach tuck and Mach buffet and the reason for them. • Buffet-limited max altitude. • Critical Mach number and aerodynamic forces acting on the wing at critical Mach. • Control surface effectiveness at high speed. **NOTE: Training for AOA and Mach effects should only be accomplished to the extent of their applicability to the specific airplane.**
Flight	The FSTD training should be accomplished at both high altitudes (within 5,000 ft. of the service ceiling of the airplane), and low altitude (below 10,000 ft. above ground level (AGL)). Use of normal operational cruise altitudes for high-altitude training should be encouraged. To fully understand the concepts discussed in academic training, pilots should demonstrate the following: • Recognize buffet (if applicable to airplane type), when encountered. • Maneuvering at high altitudes at various speeds and automation levels applying the aerodynamic principles studied to prevent an upset. • Awareness of the AOA from available data shown on the flight deck (e.g., barber pole on speed tape, pitch-limit-indicator, flight-path-symbol relative to pitch attitude, etc.) and demonstrate the use of those data to prevent an upset or recover from one.

<table>
<tr><td></td><td>Demonstrate knowledge of the type-specific systems that use AOA inputs with emphasis on warning systems and the limitations of those systems.
Speed controlled by elevator inputs or speed controlled by thrust, airplane energy state as it pertains to the type being flown, and demonstrate use of that knowledge to prevent or recover from an upset.
Roll rate performance of the airplane at different speeds and different configurations and with flight spoilers retracted/extended if a difference exists.
Pitch rate performance of the airplane at different speeds, different configurations, and with flaps retracted/extended.
Demonstrate an aft center of gravity (CG) versus forward CG if flight qualities are significantly different.
Additional details regarding these areas can be found in the Airplane Upset Recovery Training Aid (AURTA) Revision 3, section 2.5. While the AURTA was designed for swept-wing airplanes with more than 100 seats, the general concepts are still applicable to most high-performance airplanes.</td></tr>
<tr><td colspan="2">2. G Awareness</td></tr>
<tr><td>Academic</td><td>The effects of g’s, especially during airplane upsets. Emphasize that G-loading in transport category airplanes feels significantly more pronounced than in simulation. Airline pilots are normally uncomfortable (for the sake of passenger comfort and safety) with aggressively loading or unloading the G forces on a large passenger airplane. This inhibition must be overcome when faced with the necessity to quickly and sometimes aggressively maneuver the airplane. Most FFSs cannot replicate sustained load factors greater or less than 1g; therefore, the flight deck situation must be envisioned during flight different from 1g. The pilot may feel significantly heavier or lighter in the seat for moderate durations. It may be difficult to reach the rudder pedals. Unsecured items may be flying around the flight deck. However, it should be emphasized that it should not normally be necessary to maneuver at less than 0g.</td></tr>
<tr><td>Flight</td><td>Incorporated into section 8 Upset Recovery Techniques below.</td></tr>
<tr><td colspan="2">3. Energy Management</td></tr>
<tr><td>Academic</td><td>The interrelationship between kinetic energy (airspeed), potential energy (altitude), and chemical energy (power).
How the airplane gets in a high- or low-energy state and the input options available to change the energy state to a stable and safe state.
How external factors can change energy state and how to correct for them.</td></tr>
</table>

	• What parameters to focus on to decide an appropriate response; crosscheck with the other pilot to establish a shared understanding. • What to monitor during an event and how the pilot monitoring (PM) should assist the pilot flying (PF) in the recovery using appropriate callouts and other verbal feedback.
Flight	This training should include integrated Crew Resource Management (CRM) training for developing crew knowledge and skills for energy management and techniques for reducing pilot error. To fully understand the concepts discussed in academic training, pilots should demonstrate the following: • Acceleration between two speeds of which the airplane is capable at low altitude, medium, and high altitude (e.g., accelerating between 200 and 250 knots at low altitude and high altitude, which corresponds to Mach changes at high altitude) to demonstrate changes in available thrust. • Acceleration performance from region of reversed command (back side of power curve) at low altitude and high altitude. • The relationship between Maximum Cruise/Climb/Continuous Thrust and takeoff/go-around (TOGA) power settings at high altitude. • Acceleration capabilities through descent versus power application. • Wake vortex encounter behind a heavy airplane in takeoff and approach configuration.
4. Flightpath Management	
Academic	Flightpath and energy management systems: Pilots should have a thorough understanding of the normal operation, failure modes and effects, and system integration effects of flightpath and energy management systems. Training on flightpath and energy management systems should include: • Normal system operation and limitations. • Indications and modes, including crosscheck and verification of mode use and understanding of how a specific mode will command the airplane; interoperability with other systems. • Failure modes and effects. • Common model-specific failures. • Common errors to avoid and why they occur. • The importance of ensuring correct inputs to the automated systems for flightpath management and the consequences of failing to do so. • Understanding of type-specific characteristics to prevent inadvertent LOC-I events because of automation surprise (e.g., vertical speed (VS) or indicated airspeed (IAS) modes based on altitude).

	• System review when conducting recurrent training. • Knowledge of pitch attitudes, power settings, and airspeeds for common configurations and different phases of flight, as applicable to the airplane type. Manual Flight Operations: • Primary and alternate control strategies. • Nonintuitive factors. For example, it may be counterintuitive to use greater unloading control forces when recovering from a high AOA, especially at low altitudes. • Additionally, for under-wing-mounted engines it may be necessary to reduce thrust in order to reduce the AOA due to the strong pitch up forces from added thrust. • Specific aspects of the transition from automated to manual flight including transition from using a flight director to "raw data," as applicable.
Flight	Training should include abnormal operating conditions, reliance on primary flight instruments, manual flying skills, and edge-of-envelope operating conditions that could be encountered during routine operations. Examples include: • Takeoff at high weight and aft/forward CG limits. • Recognition and recovery from low-airspeed/energy condition in approach/landing configuration. • Recognition and recovery from low-airspeed/energy condition near the service ceiling. • Climb-to, steady state, and descent from service ceiling. • Unplanned transition from automated to manual flight, including transition from using a flight director to "raw data," as applicable.
5. Causes and Contributing Factors of Upsets	
Academic	• Environmentally induced upsets, which could be caused by turbulence, mountain wave, wind shear, thunderstorms, microbursts, or airplane icing. • Pilot-induced upsets which could be caused by misinterpretation or slow instrument crosscheck, improper adjustment of attitude and power, improper pilot input, inattention, distractions, spatial disorientation, pilot incapacitation, misunderstanding of autoflight modes or improper use of automated systems, transition from automated to manual modes due to system disconnect, and pilot-induced oscillation (PIO). • Mechanically induced upsets that could be caused by flight instrument anomalies/failures, autoflight anomalies/failures, flight control malfunctions/failures, or other system anomalies. • Common illusions (e.g., somatogravic illusion, the leans, Coriolis illusion, etc.) associated with LOC-I events. It should be explained

	why they occur and the importance of following procedure to avoid susceptibility to illusions. • Situations resulting in an upset due to a lack of visual cues such as a sub-threshold roll (i.e., imperceptible roll rate, generally less than three degrees per second).
Flight	Not applicable
6. Review of Accidents and Incidents Relating to Airplane Upsets	
Academic	Review of accidents and incidents related to transport category airplane upsets with focus on an understanding of the events leading to the upset, proper or improper decision-making actions that contributed to the upset, and, if applicable, recovery. Aviation Safety Action Program (ASAP), Flight Operational Quality Assurance (FOQA), and Aviation Safety Reporting System (ASRS) data can also support this discussion.
Flight	Not applicable
7. Recognition	
Academic	**a. Type-specific examples of instrument indications during developing and developed upset.** • Visual representations of the outside view and type-specific instrument indications of a variety of developing and developed upset conditions, with a focus on pitch, power, roll, and speed trend. Pilots should be provided context for each event in order for them to identify the divergence. • Some normal situations should also be included so pilots can identify what is normal versus what is not. • If applicable, discuss other cues, such as audio or buffet cues. **b. Pitch/Power/Roll/Yaw** • Pilots must have a fundamental understanding of instrumentation and flight dynamics in pitch, power, roll, and yaw in order to recognize the current state of the airplane and make the correct control inputs to arrest the divergence or recover from the upset. • The use of the AURTA Revision 3, sections 2.5.5.5–2.5.5.9, is recommended for specific details for training Pitch/Power/Roll/Yaw. **c. Effective Scanning** • Effective instrument scanning techniques should be trained, as appropriate, to recognize normal states and divergence from normal flight parameters. • To prevent flightpath divergences related to improper monitoring of airplane state, pilots should be trained during all phases of flight on what to monitor and when, crosschecking, and verification.

<table>
<tr><td></td><td>d. CRM techniques for working as a crew to return the airplane to normal flight and communicating airplane state between pilots, including CRM callouts to improve situational awareness.
Evidence shows that the PM is often in a better position to recognize adverse trends in airplane state or flight parameters than the pilot flying (PF).
The PM should be tasked with active monitoring of aircraft state and flight parameters and prompt callout of any divergence from planned and/or briefed flightpath.</td></tr>
<tr><td>Flight</td><td>The academic principles of recognition should be continuously reinforced by the instructor during flight training.</td></tr>
<tr><td colspan="2">8. Upset Recovery Techniques</td></tr>
<tr><td>Academic</td><td>Emphasize timely and appropriate intervention.
Emphasize that recovery to a stabilized flightpath should be initiated as soon as a divergence from intended flightpath is recognized.
Emphasize the need for the PF or PM to recognize a divergence as early as possible, and immediately ensure corrective action is taken to return the airplane to a stabilized flightpath rather than waiting until the airplane has developed into an established upset.
The use of an intervention strategy employed by the PM that progresses from alerting the PF of a divergence from the intended flightpath, to suggesting a course of action (advocacy and assertion), and proceeds to directly intervening by taking the controls to prevent an accident or incident. In the event that a pilot intervenes by taking control of the airplane, he should announce the transfer of control.
The attitude direction indicator (ADI), attitude display of the primary flight display (PFD), or head-up display (HUD), as applicable, is the primary control instrument for recovery from an upset.
Due to varying visibility conditions, pilots cannot depend on having adequate outside visual references.
Air carriers and Original Equipment Manufacturers (OEM) may already have policies on how to handle minor divergence from the desired flightpath for items such as bank, airspeed, heading, etc., including callouts. The intent of these procedures or CRM techniques is for the PM to draw attention to any divergence that exceeds parameters set by the company and for the PF to take corrective action.
Control inputs to counter a developing upset must be smooth, positive, and proportional to the amount and rate of pitch, roll, or yaw experienced.</td></tr>
</table>

<table>
<tr><td></td><td>Up to full-scale control deflections may be necessary; however, initiating recovery with arbitrary full-scale control deflections could aggravate the situation. An aircraft’s response to excessive or inappropriate control input that overshoots the desired response can startle or surprise the pilot and cause one upset to lead to another.
The use of the AURTA Revision 3, sections 2.6.3.2–2.6.3.5, is recommended for details to train the academic portion of the recovery techniques for the four elements below. For instructional purposes, the AURTA Revision 3 addresses several different airplane upset situations (listed below). This provides the basis for relating the aerodynamic information and techniques to specific situations.
Nose-High/Wings-level recovery.
Nose-Low/Wings-level recovery.
High Bank-Angle Recovery Techniques.
Consolidated Summary of Airplane Recovery Techniques.</td></tr>
<tr><td>Flight</td><td> The nose-high and nose-low maneuvers in Section 4, Tables 1 and 2, should be practiced first in maneuver-based training, followed by Scenario-Based Training (SBT). For the recovery from the nose-high upset, pilots are instructed to push to achieve less than 1g.
NOTE: Rudder control is still effective at a high AOA, and special care must be taken in the use of rudder during upset prevention and recovery. It is important to guard against control reversals. To maintain structural integrity, avoid rapid full-scale reversal of control deflections.
During this training, the instructor should:
Use the Instructor Operating Station (IOS) to track G-load and other flight parameters during recovery;
Provide specific feedback if recovery was too aggressive, i.e., structural or other flight limits were exceeded during recovery;
Provide specific feedback if recovery was insufficiently positive, i.e., recovery was delayed or impaired due to insufficient control inputs;
Provide specific feedback if recovery control inputs were excessive, or cyclic with control reversals; and
After the pilot uses the correct amount of force to recover, note that the absence of G-load sensing in the FSTD may lead to a tendency to undercontrol recovery in the actual aircraft when these loads are sensed.</td></tr>
</table>

9. Specialized Flight Training Elements for Upset Prevention	
Flight	Paragraph §14.062, §14.063, §14.071 and 14.120 require initial, transition, upgrade, and recurrent training Each maneuver or procedure listed below, and teaches a specific skill set to help pilots build their manual handling skills and prevent upsets. • Manually controlled slow flight: The target speed for slow flight should be below the minimum drag speed for the configuration. Slow flight exposes the pilot to flight just above the stall speed and how to maneuver the airplane at this speed, in situations other than an approach, without stalling. The purpose is to reinforce the basic stall characteristics learned in academics and allow the pilot to obtain handling experience and motion sensations when operating the airplane at slow speeds in the impending regime in various airplane attitudes, configurations, bank angles, and altitudes, including high altitudes. • Steep turns: Steep turns provide the pilot with some practical experience of the consequences of load factor and maneuvering the airplane at higher than normal bank angles. • Manually controlled loss of reliable airspeed (See Appendix 2, Scenario 2): The training of an airspeed indication system malfunction is critical for a pilot's understanding of type-specific failure modes. Additionally, cascading failure of other dependent systems provides a training environment, which allows a pilot to practice manually handling an aircraft with varying degrees of automation and capabilities that may be present during upset. In many instances, the loss of reliable airspeed results in an aircraft which must be flown primarily by relying on pitch and power. Further, these maneuvers require an understanding of the aerodynamic qualities of large transport category aircraft. • Manually controlled instrument departure and arrival: Modern aircraft are commonly operated using autoflight systems (e.g., autopilot or autothrottle/autothrust). Autoflight systems are useful tools and have improved safety and workload management, and thus enable more precise operations; however, continuous use of autoflight systems could lead to degradation of the pilot's ability to quickly recover the aircraft from an undesired state.

<table>
<tr><th colspan="2">10. System Malfunctions</th></tr>
<tr><td>Academic</td><td>Understanding of airplane systems and how system malfunctions can contribute to an upset.
Air carriers should refer to OEM checklists and procedures, which cover system and component failures.
Review additional information from the AURTA Revision 3, section 2.4.2.</td></tr>
<tr><td>Flight</td><td>System malfunctions can contribute to an upset. FSTDs allow instructors to safely induce malfunctions that would not be possible in the airplane. Failures/malfunctions related to systems, instruments, power, and automation should all be incorporated into training, whenever applicable. Inaccurate information, if possible, should also be part of the training program (e.g., unreliable airspeed), so pilots learn to recognize the error, prevent an upset, and maintain control of the airplane.</td></tr>
<tr><th colspan="2">11. Normal and Degraded Modes for Envelope Protected Airplanes</th></tr>
<tr><td>Academic</td><td>Understanding of normal modes of envelope protection, as well as all possible degraded modes of envelope protection.
Comprehensive information regarding envelope protection is available from the aircraft manufacturer.
Operator must adequately train pilots on the varied effects of envelope protection during normal, abnormal, and emergency situations.</td></tr>
<tr><td>Flight</td><td>Demonstrate flight envelope protection in normal and degraded modes. Highlight the differences in symbology, instrumentation, and flight characteristics, as appropriate.</td></tr>
</table>

APPENDIX 2. SAMPLE TRAINING SCENARIOS AND MANEUVERS

Three scenarios were constructed using the philosophies and concepts described in this advisory circular (AC). 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; they are provided as a framework for developing a training curriculum.

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

EXAMPLES OF SCENARIOS AND MANEUVERS FOR UPSET PREVENTION AND RECOVERY TRAINING

SCENARIO 1: NOSE-HIGH ATTITUDE IN AN AIRPLANE WITH UNDER-WING-MOUNTED ENGINES	
INSTRUCTOR ROLE	Implement scenarios that result in an unexpected nose-high attitude (40° or greater) with full power.
OBJECTIVE	This scenario is ONLY for airplanes with under-wing-mounted engines. The pilot will recognize the nose-high attitude and immediately perform the upset recovery procedure. If a detectable nose-down pitch rate is not initially achievable, the pilot should demonstrate recovery by reducing the thrust to a point where a nose-down pitch rate is achieved.
EMPHASIS AREAS	• Effect of thrust on pitch moment. • Recognition and recovery. • Crew coordination. • Angle of attack (AOA) management, including available AOA indications. • Aural and visual warnings (environment and airplane cueing). • Surprise and startle. • Situational awareness while returning to desired flightpath after the upset recovery, including such items as heading, altitude, other aircraft, and flight deck automation.
FSTD SETUP CONSIDERATIONS	In order to create potential onset conditions, consider use of the following: • System malfunctions resulting in erroneous pitch attitude indications; • Other system malfunctions resulting in a nose high attitude;

SCENARIO 1: NOSE-HIGH ATTITUDE IN AN AIRPLANE WITH UNDER-WING-MOUNTED ENGINES	
	• Realistic environmental threats destabilizing the flightpath.
SCENARIO ELEMENTS	• Upon recognizing the first indication of an upset, perform the upset recovery procedure. • The necessity for smooth, deliberate, and positive control inputs to avoid increasing load factors. • Reducing thrust, if necessary, can reduce the upward pitch moment.
COMPLETION STANDARDS	• Recognizes and confirms the situation. • Initiates recovery by reducing thrust to approximately midrange until a detectable nose-down pitch rate is achieved. • Verifies the autopilot and autothrottle/autothrust are disconnected. • Proper recovery consists of up to full nose-down elevator and by using stabilizer trim, if required. A steady nose-down pitch rate should be achieved and it should be noted that the airplane would be less than 1g and the associated characteristics of such. • When approaching the horizon the pilot checks airspeed, adjusts thrust, and establishes the appropriate pitch attitude and stabilizer trim setting for level flight. • The maneuver is considered complete once a safe speed is achieved and the airplane stabilized. • Satisfactory crew coordination must be demonstrated.
COMMON PILOT ERRORS	• Fails to disengage the autopilot and autothrottle. • Fails to reduce thrust sufficiently, if necessary, to obtain nose-down pitch. • Reduces thrust excessively. • Fails to use sufficient elevator authority. • Fails to use stabilizer trim when necessary.
COMMON INSTRUCTOR ERRORS	• Fails to notice improper control inputs. • If the FSTD training envelope was exceeded, fails to advise the pilot to prevent negative training.

SCENARIO 1: NOSE-HIGH ATTITUDE IN AN AIRPLANE WITH UNDER-WING-MOUNTED ENGINES	
SCENARIO 2: LOSS OF RELIABLE AIRSPEED	
INSTRUCTOR ROLE	Implement scenarios that result in erroneous airspeed indications.
OBJECTIVE	The pilot will recognize the airspeed discrepancy, determine airspeed data is erroneous, and apply the appropriate non-normal procedure while maintaining airplane control using pitch and power targets.
EMPHASIS AREAS	• Recognition. • Crew coordination. • AOA management including available AOA indications. • Maintain awareness of and manage flightpath and energy. • Aural and visual warnings (environment and airplane cueing). • Completion of the appropriate non-normal checklist. • Surprise and startle. • Manual flying skills. • Effects of altitude on control inputs.
FSTD SETUP CONSIDERATIONS	The scenario will be conducted at or near the maximum operating altitude in instrument meteorological conditions (IMC). Use of flight simulation training device (FSTD) capabilities to induce erroneous airspeed indications may include: • Full or partial pitot/static blockage or icing. • Air data computer failures.
SCENARIO ELEMENTS	• During cruise, one or two airspeed indicators will malfunction. • The pilot recognizing the erroneous airspeed data indication will verbally announce the discrepancy. • The pilot flying will maintain control of the airplane and call for the appropriate non-normal checklist. • At the conclusion of the scenario, the instructor will discuss available airplane AOA indications.

SCENARIO 1: NOSE-HIGH ATTITUDE IN AN AIRPLANE WITH UNDER-WING-MOUNTED ENGINES	
COMPLETION STANDARDS	• The pilot flying will manage pitch and power to avoid a stall. • Satisfactory crew coordination must be demonstrated. • Correctly identifies the erroneous airspeed data. • Completes the appropriate non-normal checklist. • Verifies the autopilot and autothrottle/autothrust are disconnected. • The pilot monitoring provides the pilot flying with meaningful input (e.g., attitude and altitude deviations and trends).
COMMON PILOT ERRORS	• The importance of pitch control and AOA is not recognized. • Use of large thrust changes. • Failure to complete the appropriate non-normal checklist. • Over controlling the airplane, especially pitch.
COMMON INSTRUCTOR ERRORS	• Fails to notice improper control inputs. • If the validated FSTD envelope was exceeded, fails to advise the pilot and stop the scenario to prevent negative training.

SCENARIO 1: NOSE-HIGH ATTITUDE IN AN AIRPLANE WITH UNDER-WING-MOUNTED ENGINES	
SCENARIO 3: SUB-THRESHOLD ROLL	
INSTRUCTOR ROLE	Implement scenarios that cause an imperceptibly slow roll rate (less than 3° per second) that result in an unexpected high bank angle.
OBJECTIVE	The pilot will recognize the high bank angle and immediately perform the upset recovery procedure.
EMPHASIS AREAS	• Recognition and recovery. • Crew coordination. • AOA management. • Out-of-trim control forces at autopilot disconnect (if engaged). • Aural and visual warnings (environment and airplane cueing). • Surprise and startle. • Effects of multiple levels of automation. • Effects of altitude on recovery. • Situational awareness while returning to desired flightpath after the upset recovery, including such items as heading, terrain, altitude, other aircraft, and flight deck automation.
FSTD SETUP CONSIDERATIONS	The scenario will be conducted at an altitude that will allow for a recovery. Crew distractions may be used (e.g., minor malfunctions, air traffic control (ATC) instructions, weather). Use of FSTD capabilities to induce a slow, imperceptible roll rate (less than 3° per second) may include: • Attitude changes, • Thrust asymmetry, • System malfunctions (e.g., surreptitious disabling of automation). • Dynamic upsets should not be implemented in a manner that disables or unrealistically reduces flight control effectiveness for the purpose of generating or attaining an upset condition.
SCENARIO ELEMENTS	• The instructor will introduce a situation which causes the airplane to enter an imperceptible roll resulting in an unexpected bank angle greater than 30°. • Either pilot will notice and announce the excessive bank.

SCENARIO 1: NOSE-HIGH ATTITUDE IN AN AIRPLANE WITH UNDER-WING-MOUNTED ENGINES	
	• The pilot flying will demonstrate the proper recovery procedure. • Disengage the autopilot and autothrottle. • If a nose-high or nose-low condition exists, identify the situation and apply the correct recovery. • Maintain awareness of energy management and airplane roll rate. • Unload (reduce AOA) as necessary and roll to wings level as the nose approaches the horizon. Recover to a slightly nose-low attitude. Check airspeed and adjust thrust and pitch as necessary. • When recovery is assured, adjust the pitch attitude to return to the intended flightpath.
COMPLETION STANDARDS	• Rolls in the shortest direction to wings level. • Returns the airplane to the assigned flightpath. • Satisfactory crew coordination must be demonstrated.
COMMON PILOT ERRORS	• Recovery is initiated by rolling in the wrong direction, increasing the bank. • Losing situational awareness and failing to return to assigned flightpath or follow ATC instructions after recovery. • Pilot(s) slow to recognize or announce the excessive bank. • Executes improper recovery procedure. • Failure to disengage the autopilot and/or autothrottle/autothrust. • Slow to reduce angle of attack (unload). • Failure to maintain awareness of energy management.
COMMON INSTRUCTOR ERRORS	• Fails to notice improper control inputs. • If the FSTD training envelope was exceeded, fails to advise the pilot and stop the scenario to prevent negative training.

SCENARIO 1: NOSE-HIGH ATTITUDE IN AN AIRPLANE WITH UNDER-WING-MOUNTED ENGINES	
MANEUVER 1: MANUALLY CONTROLLED SLOW FLIGHT	
OBJECTIVE	Recognize the low energy or high drag configuration and the slow response to flight control and thrust inputs to enhance the pilot's knowledge of the low speed handling qualities prior to stall training.
EMPHASIS AREAS	Manual flying skills

FSTD SETUP CONSIDERATIONS	• Select ceiling and visibility unlimited.
	• The maneuver will be conducted in the following two scenarios:
	  o Low altitude beginning in a clean configuration, and then slowing while configuring the airplane for landing. This maneuver will be conducted at maximum landing gross weight.
	  o High altitude in a clean configuration (e.g., near the service ceiling), near maximum gross weight while maintaining minimum speed for the configuration.
	• Target speeds should be below the minimum drag speed for the various configurations. The minimum speed must avoid stick shaker. Ideally a single speed can be selected for use throughout the maneuver that will permit judicious maneuvering without stick shaker. Encountering stick shaker without executing a stall recovery could lead to negative training.

SCENARIO ELEMENTS	• While maintaining altitude, slowly establish the pitch attitude (using trim or elevator or stabilizer), bank angle, and power setting that will allow a controlled speed reduction to establish the desired target airspeed. • Maneuver in straight and level flight to stabilize speed and trim. • Turn left and right, and change direction of turn, to observe changing handling characteristics. • Turns through 90º left and right, at bank angles appropriate to speed and configuration. • Climb and descend at 500 feet per minute (fpm) while in a turn.

SCENARIO 1: NOSE-HIGH ATTITUDE IN AN AIRPLANE WITH UNDER-WING-MOUNTED ENGINES	
COMPLETION STANDARDS	• Recover to appropriate airspeed for the configuration and establish the appropriate altitude and heading. • Recovery is complete when straight and level un-accelerated flight is achieved.
COMMON PILOT ERRORS	• Inadequate back-elevator pressure as power is reduced, resulting in altitude loss. • Excessive back-elevator pressure as power is reduced, resulting in a climb, followed by a rapid reduction in airspeed and “mushing.” • Inadequate compensation for adverse yaw during turns. • Fixation on the airspeed indicator. • Failure to anticipate changes in lift as flaps are extended or retracted. • Inadequate power management. • Inability to adequately divide attention between airplane control and orientation.

APPENDIX 3. FLIGHT SIMULATION TRAINING DEVICE (FSTD) CONSIDERATIONS

1. SUMMARY OF FSTD CAPABILITIES.

a. FSTDs are a key element of a pilot training program, because they are a cost-effective and safe alternative to performing training in the actual airplane while providing the capability to train certain tasks which cannot be easily trained in the actual airplane. Abnormal and emergency procedures that could not be trained in the actual airplane can be trained in an FSTD, in a risk-free environment, with an adequate level of fidelity when operated within its training limits.

b. An FSTD is a synthetic environment, which cannot fully replicate the exact experience of an aircraft; however, there is reason to be confident that the appropriately qualified FSTD has satisfactory fidelity for training normal, abnormal, and emergency procedures. In consideration of the normal limitations of FSTDs (such as aerodynamic validation, and motion cueing limitations), there is concern that practicing upset recovery techniques could include inadvertent excursions beyond its intended training envelope. This concern may be overcome if instructors have a better understanding of the FSTD limitations and additional instructor tools, which is why this advisory circular (AC) puts special emphasis on instructor training and qualification.

2. FSTD EVALUATION REQUIREMENTS.

a. Since the original publication of this AC, FSTD evaluation and qualification requirements have been codified in VAR §14.155 which requires that all FSTDs being used for Upset Prevention and Recovery (UPRT) maneuvers must be specifically evaluated and qualified for such maneuvers.

b. Any FSTD being used to conduct UPRT must be qualified as ICAO' Doc 9625 Manual of Criteria for the Qualification of Flight Simulation Training Devices Volume 1 - Aeroplanes Fourth Edition, 2015 and/or further editions.

3. INSTRUCTOR TOOLS FOR UPRT. To support UPRT in an FSTD, additional tools and capabilities should be made available to the instructor for briefing, training, and debriefing UPRT maneuvers. This may include video and audio capability, preprogramed distractors/initiators, as well as feedback tools to determine if the recovery maneuver has exceeded FSTD limits or airplane operational limits.

a. A set of simple instructor controls which can aid the instructor in developing distractors. The distraction should be a nonstandard event such that the crew thought process and the actions they take are not based on the use of the checklist. These may be weather related, traffic, air traffic control (ATC), or other such inputs which may create a distraction.

b. A dynamic set of upsets, which may be a result of internal or external factors. The intentional degradation of FSTD functionality (such as degrading flight control effectiveness) to drive an airplane upset is generally not acceptable unless used purely as a tool for repositioning the FSTD with the pilot out of the loop. Aircraft system malfunctions or other malfunctions may be utilized to stimulate an aircraft upset, however the effects of these malfunctions must be representative of the aircraft and, where possible, supported by data.

- A set of upset initiation features (e.g., autothrottle/autothrust disconnection not commanded by the pilot) designed to assess the prevention of an upset event by the crew. The objective of this upset feature is to generate a condition that, if the crew does not recognize it and take timely corrective action, it will continue to develop and result in an upset.

- A set of upset initiation features (e.g., sub-threshold roll) designed to lead the crew to initiate recognition measures. The objective of this upset feature is to generate a developing upset condition so that crew action will prevent a fully developed upset condition.
- A set of upset initiation features (e.g., a full pitch up using external stimuli) designed specifically to progress in severity so that the crew has to initiate recovery measures. The objective of this upset feature is to generate a developed upset condition so that the crew has to initiate appropriate recovery action to prevent further loss of control.

c. Instructor feedback tools should be provided which indicate if airplane operating limits are exceeded, the parameters monitored may include the following:

- Airspeed limitations,
- Maximum operating speed,
- Maneuvering speed,
- Flap extended speed,
- Minimum control speed,
- Landing gear speeds,
- Rough air speed,
- Altitude limitations,
- Powerplant limitations, and
- Maneuvering flight load factors including simultaneous roll and pitch.

d. The instructor should be provided with an indication of when the FSTD has exceeded the validation limits of its aerodynamic model. The model limits may be based upon an angle of attack and sideslip range as defined by the FSTD's aerodynamic model provider. Refer to Appendix 3-D, Flight Simulator Information, of the Airplane Upset Recovery Training Aid (AURTA) Revision 3.

e. The instructor should be provided with an indication of when an airplane limit is:

- Approached (cautionary warning—amber) or reasonable margins as appropriate can be used; the intent is to give the instructor an initial indication that the airplane is operating close to a limit.
- Exceeded (exceedance warning—red). The simulation should not automatically freeze unless the limit is exceeded by a predefined margin that voids the training or can cause an unsafe condition on the FSTD.

f. The dividing line between a valid and invalid training envelope may be grey instead of being represented by a clear line on an instructor's display. While an instructor may adopt a conservative approach by repeating a maneuver that caused the FSTD to exceed its training envelope slightly, it is more important for both the instructor and trainee to recognize that the objective is not to convey the precise aircraft response but to reinforce the proper recovery technique. The actual response of the aircraft may vary whether inside or outside the intended training envelope. Ultimately, sound judgment is required on the part of the instructor, which can best be applied through an adequate understanding of an FSTD's limitations.

4. FSTD MOTION LIMITATIONS. Pilot control inputs are often highly influenced by load factor, or g. Unfortunately, a pilot in a typical FSTD feels less than 10 percent of the actual airplane g. Both the instructor and trainee need to be aware of this difference between flight and simulation. Upset recoveries in an FSTD at high altitudes can be prone to oscillations that go unnoticed if the full suite of available pilot and instructor displays are not used. As such, it is important for the instructor to be alert for such problematic recoveries, convey the errors appropriately to the trainee if they occur, and repeat the maneuvers until the trainee is proficient.