Model RASG-AFI Advisory Circular on Loss of Control-In-Flight (LOC-I)
And
Upset Prevention and Recovery Training (UPRT)

AC-RASG-AFI-01
Date: First issue-August 2018
Revision 3-November 2021

Subject: Upset Prevention and Recovery Training

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, air operators, training organizations, industry representative organizations and RASG-AFI Champion for LOC-I.

Although this AC is directed to air operators to implement requirements for international air operations, all airplane operators, pilot schools, and training centers are encouraged to implement UPRT and to use this guidance, as applicable to the type of airplane in which training is conducted.

Core principles of this AC include:

- Enhanced instructor training on the limitations of simulation.
- Comprehensive pilot academic training on aerodynamics.
- Early recognition of divergence from intended flightpath.
- Upset prevention through improvements in manual handling skills.
- Training that integrates crew resource management including progressive intervention strategies for the pilot monitoring.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

1-1 BACKGROUND

Based on accident reviews, a concern exists regarding loss of control in- flight (LOC-I) accidents. As LOC-I is generally a consequence of an airplane upset.

1-2 GENERAL

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, UPRT is an essential training element to reduce loss of control events or, if they occur, enable recovery to normal flight.

1-3 REGULATORY REQUIREMENTS

Air operators must include UPRT for pilots during:

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

1-4 AIR OPERATORS CONDUCTING TRAINING IN AIRPLANES

a. Air operators are required to conduct the following extended envelope training manoeuvres discussed in this AC to be conducted in a Level C or higher full flight simulator (FFS):

b. manually controlled slow flight, manually controlled loss of reliable airspeed, manual controlled instrument departure and arrival, and upset recovery manoeuvres. Air operators are encouraged to use the highest fidelity level FFS available.

c. 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 manoeuvres and employ risk mitigation strategies. Airplanes used for flight training elements should be those designed for the specific manoeuvres being conducted, and training programs should use instructors specifically qualified to conduct UPRT in airplanes. Air operators conducting UPRT in airplanes should follow the guidance and associated risk mitigation strategies contained in ICAO's Doc 10011, Manual on Aeroplane Upset Prevention and Recovery Training.

1-5. DEFINITIONS

For the purpose of this AC, the following definitions and terms are provided:

a) **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.

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

c) **Awareness**
Knowledge or perception of the situation

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

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

f) **Distraction**
The diversion of attention away from the primary task of flying

g) **Tended Envelope Training**
The flight training consists of:

- Manually controlled slow flight;
- Manually controlled loss of reliable airspeed;
- Manually controlled instrument departure and arrival;
- Upset recovery manoeuvres;
- Instructor-guided hands on experience of recovery from full stall and stick pusher activation.

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

i) **Flightpath Management**
Active manipulation, using either on board 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

j) **Operating Station (IOS)**
The interface panel between the FSTD instructor and the FSTD

k) **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.

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

m) **Manoeuvre-Based Training**
Training that focuses on a single event or manoeuvre in isolation.

n) **Prevention**
Actions to avoid any divergence from a desired airplane state

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

p) **Startle**
An uncontrollable, automatic muscle reflex, raised heart rate, blood pressure, etc., elicited by exposure to a sudden, intense event that violates a pilot's expectations.

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

r) **Transfer of Training**
The ability of a trainee to apply knowledge, skills, and behaviour 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.

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

1-6 RELATED REFERENCES

Annex 1- Personnel Licensing
Annex 6- Operation of Aircraft
Airplane Upset Prevention and Recovery Training Aid-Revision3 (AUPRT-Rev3) (https://www.icao.int/safety/LOCI/AUPRTA/index.html)

Manual on Aeroplane Upset Prevention and Recovery Training (Doc 10011)
Manual of Criteria for the Qualification of Flight Simulation Training Devices (Doc 9625)
Manual of Evidence-based Training (Doc 9995)
Procedures for Air Navigation Services-Training (PANS-TRG, Doc 9868)

Safety Management Manual (SMM) (Doc 9859)
FAA AC_120-111
FAA AC_120-109A
FAA FSTD_Directive-2
IATA Guidance Material and Best Practices for the Implementation of Upset Prevention and Recovery Training

Additional guidance materials can be found at:

https://www.icao.int/ESAF/Pages/loci-symp-2015.aspx

https://www.icao.int/ESAF/Pages/loc-i_uprt_2016.aspx

https://www.icao.int/ESAF/Pages/LOC-I_UPRT-2017.aspx

https://www.icao.int/ESAF/Pages/loc-i_uprt_2018.aspx

https://www.icao.int/ESAF/Pages/loc-i-and-uprt-2019.aspx

https://www.icao.int/ESAF/Pages/LOCI-UPRT-2020.aspx

https://www.icao.int/ESAF/Pages/LOC-I-and-UPRT-2021.aspx

CHAPTER 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 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 flight training (LOFT).

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.

d) **Completion Criteria for Recovery.** Timely action to recover from an upset in accordance with the air operator's procedures, or in the absence thereof, in accordance with recommendations provided in Chapter 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

UPRT instructors must meet the following requirements:

- Hold an ATP licence and airplane type rating in the airplane for which they are conducting training.
- Successfully complete the licence 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 FSTD 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 behaviour 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 AUPRT-Rev3 for more information.

b. Instructor Operating Station (IOS) Use

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 IOS 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 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 manoeuvres 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 Collision and Avoidance System 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 operator 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.

h. 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.

i. 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.

j. 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 ON-AIRPLANE INSTRUCTORS

On-aeroplane instructors shall meet the requirements as specified in Annex 1, sections 2.1.8 and 2.8, respectively, entitled "circumstances in which authorization to conduct instruction is required" or "flight instructor rating appropriate to aeroplanes, airships, helicopters and powered-lifts". Prior to qualifying, on-aeroplane instructors assigned to conduct UPRT should be assessed by the CAA and ATO as successfully demonstrating competency in:

a) accurately deliver the training curriculum employing sound instructional techniques;

b) understanding the importance of adhering to the UPRT scenarios, during the lesson, that were validated by the training programme developer;

c) accurately assessing a trainee's performance levels and providing effective remediation;

d) recovering the aeroplane in those instances when corrections are required which could exceed the capabilities of the trainee;

e) foreseeing the development of flight conditions which might exceed aeroplane limitations and acting swiftly and appropriately to preserve necessary margins of safety;

f) projecting the aeroplane's flight path and energy state based on present conditions with consideration to both current and anticipated flight control inputs; and

g) determining when it becomes necessary to discontinue training to maintain safety and the well-being of the trainee.

CHAPTER 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 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 a developing flightpath divergence, respond appropriately in situations of surprise or startle, and recover effectively when required. Air operators 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 ICAO Doc 10011.

3-2 COMPREHENSIVE AIR OPERATOR UPRT PROGRAM

a . General

A comprehensive training programme should have the following UPRT components:

a) *academic training* — designed to equip pilots with the knowledge and awareness needed to understand the threats to safe flight and the employment of mitigating strategies; and

b) *practical training* — designed to equip pilots with the required skill sets to effectively employ upset avoidance strategies and, when necessary, effectively recover the aeroplane to the originally intended flight path. The practical training component is further broken down into two distinct subcomponents involving:

1) *on-aeroplane training* — during CPL(A) or MPL training in suitably capable light aeroplanes to be conducted by appropriately qualified instructors to develop the knowledge, awareness and experience of aeroplane upsets and unusual attitudes, and how to effectively analyse the event and then apply correct recovery techniques; and

2) *FSTD training* — on specific or generic aeroplane types to build on knowledge and experience, and apply these to the multi-crew crew resource management (CRM) environment, at all stages of flight, and in representative conditions, with appropriate aeroplane and system performance, functionality and response. This instruction should only be provided by appropriately qualified instructors.

The UPRT training elements, components and platforms are included in Table2-1 of ICAO Doc 10011-Manual of Upset Prevention and Recovery Training.

The On-aeroplane UPRT elements are included in Table 3-1 of Doc 10011.

The Non-type-specific FSTD multi-crew UPRT elements are include in Table3-2 of Doc 10011

The Type-specific FSTD training elements are included in Table3-3 of Doc 10011

Competency-based UPRT training elements should be conducted based on Appendix of Doc 10011

Recommendations included in the Airplane Upset Recovery Training Aid (AUPRT)-Rev3 should be incorporated into air operator UPRT programs. The AUPRT-Rev3 has extensive discussion and considerations for both the academic and flight training portion of an air operator’s training program.

Training undergone under an FAA or EASA approved training centre or programme is considered as meeting the criteria set forth in this advisory circular.

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

Extended envelope training consists of the following manoeuvres 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, upset recovery manoeuvres and instructor-guided hands on experience of recovery from full stall and stick pusher activation. 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 manoeuvres 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 modelling 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 behaviour may differ.

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

(a) **Manoeuvre-Based Training.** This training focuses on task mastery.
Manoeuvre-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 manoeuvre-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 manoeuvre-based training in a realistic scenario. SBT would normally be used after manoeuvre-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 Reporting System (ASRS) data and data derived from Safety data collection and processing systems (SDCPS) to convey how threat situations may develop and how they should be managed.

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 operator'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); Early detection of flightpath divergences;

3) Timely and appropriate intervention;

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

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

6) Effective verbal and non-verbal 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: Air operators 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 manoeuvres are included in Appendix 1 specifically to develop and maintain a pilot's manual flight operations knowledge and skills.

(2) Operations

Air operators 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 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

Some accidents and incidents resulting from pilot loss of airplane state awareness have 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 manoeuvres 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.

CHAPTER 4: UPSET RECOVERY TEMPLATES

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

Templates included in ICAO Doc 10011 and OEM Recommended Training Sequences in the AUPRT-Rev3 show the Nose High and Nose Low Upset Recovery Templates that were developed with inputs from relevant 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 operators operating airplanes without manufacturer upset recovery procedures, the templates should be used as a reference when developing air operator-specific upset recovery procedures.

NOTE:

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

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

c. If needed, use pitch trim sparingly. Careful use of rudder to aid roll control should be considered only if roll control is ineffective.
d. A pilot who is aware of the energy and flight path is less likely to be startled and therefore, more likely to deal with the situation with controlled inputs versus reactive responses.
e. Control inputs appropriate at one point in the flight envelope might not be appropriate in another part of the flight envelope.
Pilots must have a fundamental understanding of flight dynamics in order to correctly determine the control input(s) necessary.
f. Exceed the critical angle of attack and the surface will stall, and lift will decrease instead of increase. This is true regardless of airplane speed or attitude or wing shape.
g. For Turboprop: Anytime, asymmetry exists due to power effects sufficient coordinated rudder and lateral inputs will be required to maintain the desired flight path.
h. For Turboprop: In a one-engine inoperative condition, airplane controllability and climb performance capability are based on the assumption the propeller of the failed engine is feathered and the airspeed is maintained at or above the minimum airspeeds defined in the AFM.
i. At any speed, large aggressive control deflection reversals can lead to loads that can exceed structural design limits.
j. Pilots must be or become situationally aware before they are able to take appropriate actions.
k. Troubleshooting the cause of the upset is secondary to initiating the recovery. However, the pilot still must recognize and confirm the situation before a recovery can be initiated. Regaining and then maintaining control of the airplane is paramount.

l. Troubleshooting the cause of the upset is secondary to initiating the recovery and regaining control of the airplane.
m. It is critical to guard against control reversals.
n. Altitude cannot be maintained and should be of secondary importance.
o. Training related to upset and/or stalls should emphasize awareness and avoidance.
Situationally aware flight crews are those who actively monitor their flight.
As such, they are able to assess the energy, arrest any flight path divergence and recover to a stabilized flight path before an extreme upset ever occurs.
p. The recovery techniques assume the airplane is not stalled.
If the airplane is stalled, it is necessary to first recover from the stalled condition before initiating upset recovery techniques.
Follow your OEM procedure for stall recovery.
q. Warning: excessive use of pitch trim or rudder may aggravate the upset situation or may result in high structural loads.
r. Only a small amount of rudder input is needed. Too much rudder applied too quickly or held too long may result in loss of lateral and directional control and cause structural damage.
s. Warning: excessive use of pitch trim or rudder may aggravate the upset situation or may result in high structural loads.
t. Only a small amount of rudder input is needed. Too much rudder applied too quickly or held too long may result in loss of lateral and directional control and cause structural damage.
u. This is not to develop skills in manoeuvring with rudder. Rather it is intended to highlight airplane reaction to rudder input and the risk of over control or untimely rudder input (deflection when not needed).

CHAPTER 5: STALL TRAINING CURRICULUMS

5-1 GENERAL

a. Common Guidance

This chapter provides common guidance for all stall prevention and recovery training curriculums, while Chapters 4 and 5 provide detailed information for stall prevention training and stall recovery training, respectively. An effective stall training curriculum should provide pilots the knowledge and skills to avoid undesired aircraft states that increase the risk of encountering a stall event or, if not avoided, to respond correctly and promptly to a stall event. The reason for using the term “stall event” is to emphasize that the recovery technique for an impending stall or full stall is the same.

b. Stall Event Training

Stall event training must include both ground and flight training. The training methodology should follow the building block approach of first introducing essential concepts and academic understanding during ground training before progressing to the practical application of those skills in an FFS. Similarly, familiarity with airplane characteristics and development of basic recovery handling skills through manoeuvre-based training should precede their application in scenario-based training. This progressive approach leads to a more complete appreciation of how to recognize an impending stall, respond appropriately in situations of surprise, and recover effectively when required. Training providers should develop training curriculums that provide pilots with the knowledge and skills to recognize, prevent, and recover from unexpected stall events. These training curriculums should contain the elements described in this AC.

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

5-2 TRAINING GOALS

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

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

b. Knowledge of stall fundamentals, including factors that affect stall speed and any implications for the expected flight operations.

c. Understanding of the stall characteristics for the specific airplane.

d. Proper aeronautical decision-making skills to avoid stall events (e.g., effective.

e. analysis, awareness, resource management, mitigation strategies, and breaking

f. the error chain through airmanship and sound judgment).

g. Proper recognition of an impending stall in varied conditions and configurations.

h. The effects of autoflight, flight envelope protection in normal and degraded modes, and unexpected disconnects of the autopilot or autothrottle/autothrust.

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

m. Proper application of the stall recovery procedure.

The essential concepts of stall training should be stand-alone training. Once the concepts are mastered, stall training may be incorporated into other training areas (e.g., CRM, adverse weather training, etc.). Air operators must include stall event training for pilots during:

- Initial training,
- Transition training,
- Differences and related aircraft differences training (if differences exist),

- Upgrade training,
- Requalification training (if applicable), and
- Recurrent training.

5-4 INSTRUCTOR/EVALUATOR STANDARDIZATION

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

a. Instructor/Evaluator Training

Instructor/evaluator training should focus on the practical application of these principles and the evaluation of a pilot's understanding of the airplane's operating characteristics. Instructors should:

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

b. Understanding of FFS Limitations

Instructors/evaluators must have a clear understanding of the FFS limitations that may influence the stall event training including:

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

5-5 RECOVERY PROCEDURES

This AC emphasizes using the same procedure for both stall prevention and stall recovery. Previous training and evaluation profiles that required a specific set of pilot-initiated, precise entry procedures have been replaced with realistic scenarios. Additionally, recovery profiles that emphasize zero or minimal altitude loss and the immediate advancement of maximum thrust have been eliminated. Recovery procedures now emphasize:

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

CHAPTER 6: GROUND/ACADEMIC TRAINING FOR UPRT

6-1 ACADEMIC KNOWLEDGE

Academic instruction establishes the foundation from which situational awareness (SA), insight, knowledge, and skills are developed. Academic knowledge should proceed from the general to the specific. Including accident, incident, or Aviation Safety Reporting System (ASRS) data from stall-related events is a useful way of bringing theoretical knowledge into an operational perspective.

6-2 KNOWLEDGE AREAS

The following knowledge areas should be included in all airplane training curriculums:

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

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

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

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

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

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

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

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

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

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

- AOA versus pitch angle;
- Rate of onset including rate of airspeed decay (both low and high);
- Airplane configuration and condition including weight, center of gravity (CG), landing gear, flaps/slats, spoilers/speed brakes, etc.;
- Asymmetric loading including thrust asymmetries, wing loading due to roll or yaw transients or uncoordinated flight;
- G loading;
- Bank angle;
- Thrust and lift vectors;
- Thrust required versus thrust available;
- Wind shear;
- Altitude;
- Mach effects;

- Situational Awareness
- Mode confusion, including unexpected/unannounced mode changes;
- Unexpected transition from automated to manual flight; and
- Contamination (ice), including the effect of icing on stall speed and stall warnings.

c. Airplane-Specific Systems Knowledge

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

(2) Specific stall and low speed buffet characteristics unique to the airplane type and any implications for the expected flight operations and airplane-specific stall recovery procedure (e.g., underwing mounted engines, t-tail, propellers, etc.).

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

(4) Thrust settings and its application.

(5) Autothrottle/autothrust protection.

(6) Awareness of autoflight mode indications.

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

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

d. High Altitude Considerations.

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

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

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

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

a. Airplane Certification Differences

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

b. Example Events

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

CHAPTER 7: STALL PREVENTION TRAINING

7-1 GENERAL

This chapter provides specific information for training stall prevention. Prevention training provides pilots with the skills to recognize conditions that increase the likelihood of a stall event if not effectively managed. Prevention training must include the operator's standard operating procedures (SOP) and CRM for proper avoidance techniques and threat mitigation strategies.

7-2 SIMULATOR TRAINING

Training providers are encouraged to use the highest level FFS available when developing their stall prevention and recovery training curriculums. The primary emphasis is to provide the pilot with the most realistic environment possible during impending stall training. Simulator training can either be manoeuvre-based or scenario-based; both methods are discussed in detail below.

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

a. Manoeuvre-Based Training

This training focuses on the mastery of an individual task or tasks. Manoeuvre-based training applies to both prevention and recovery training. It should emphasize the development of the required perception and motor skills to satisfactorily accomplish stall prevention and recovery. Limited emphasis should be placed on decision-making skills during manoeuvre-based training.

(1) Configurations. Manoeuvre-based training should include impending stalls in the following configurations:

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

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

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

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

(c) Visual and instrument flight conditions;

(d) High altitudes near the airplane's maximum altitude and low altitudes within 500 feet above ground level (AGL); and

(e) Various weights and CG locations within airplane limitations.

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

(a) **Recovery Procedures.**

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

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

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

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

5. Secondary stall warnings are indicative of a pilot prioritizing minimum loss of altitude over proper stall recovery or flight control inputs that are too aggressive. In some airplanes, depending on AOA representations, it may be difficult to determine the point where the pitch can begin to be increased and a momentary secondary stall warning may be encountered. A secondary stall warning is acceptable as long as AOA is promptly reduced and the airplane's limitations are not exceeded.

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

(b) Factors Leading to a Stall Event.

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

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

(c) Airplane-Specific Knowledge.

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

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

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

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

(d) Altitude Effects.

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

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

b. 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). Emphasis should be placed on preventing conditions that may lead to a stall event. SBT would normally be used after a pilot demonstrates proficiency in manoeuvre-based training and during advanced stages of training, such as upgrade training and recurrent training.

(1) Scenarios. When possible, scenarios should include accident, incident, ASAP, FOQA, and/or ASRS data to provide realistic opportunities to see how threat situations may develop and how they should be managed during line operations. Sample SBT lesson plans are provided in Appendix 3.

(2) Briefing. Pilots should not normally be briefed that they are receiving SBT. The concept is line-oriented flying, which allows the pilots to recognize and manage the expected or unexpected stall threats as they develop during normal operations. However, situations may arise where pilots exhibit excellent stall prevention skills and initiate a recovery prior to the complete unfolding of a scenario. That is the desired objective. In those instances, the instructor has the discretion whether to repeat the scenario and then showing and discussing how the many cues typically cascade as the event progresses. Such explanations can reinforce a pilot's knowledge and allow sharpening of awareness and prevention skills.

7-3. USING SURPRISE IN TRAINING. Although it may be difficult to create surprise in the training environment, if achieved, surprise events may provide a powerful lesson for the crew. The goal of using surprise in training is to provide the crew with a surprise experience to reinforce timely application of the effective recovery technique under potentially confusing circumstances. Considerable care should be used in surprise training to avoid a negative learning experience.. Stall prevention training should incorporate event conditions and variables typical of an unintentional stall that are likely to result in surprise due to the unexpected stall development, presentation, and behaviour.

CHAPTER 8: PILOT MONITORING

8.1 General. Several studies of crew performance, incidents, and accidents have identified inadequate monitoring and cross-checking as vulnerabilities for aviation safety. Effective monitoring and cross-checking can be the last barrier or line of defense against accidents because detecting an error or unsafe situation may break the chain of events leading to an accident. Conversely, when this layer of defense is absent, errors and unsafe situations may go undetected, potentially leading to adverse safety consequences. Flight crews must use monitoring to help them identify, prevent, and mitigate events that may impact safety margins. Therefore, it is imperative that operators establish operational policy and procedures on PM duties, including monitoring, and implement effective training for flight crews and instructors on the task of monitoring to help the PM expeditiously identify, prevent, and mitigate events that may impact safety margins.

This section describes effective monitoring, how to define and train PM duties, and integration of monitoring into SOPs. Additionally, the section discusses special considerations for monitoring autoflight operations.

8.2 Effective Monitoring. A pilot is effectively monitoring if he or she is:

1. Following SOPs consistently;
2. Clearly communicating deviations to other crewmembers;
3. Effectively managing distractions;
4. Remaining vigilant;
5. Advising the PF if the flight guidance modes or aircraft actions do not agree with expected or desired actions and intervening if necessary;

6. Continuously comparing known pitch/power settings to current flightpath performance; and

7. Considering that the primary flight displays (PFD), navigation displays (ND), and other sources of information (for example, electronic flight bag (EFB)), might be displaying incorrect information and always on the lookout for other evidence that confirms or disconfirms the information the displays are providing.

8.3 **Challenges and Barriers to Effective Monitoring.** There are several potential challenges and barriers to effective monitoring:

8.3.1 Time Pressure. Time pressure can exacerbate high workload and increase errors. It can also lead to rushing and "looking without seeing."

8.3.2 Lack of Feedback to Pilots When Monitoring Lapses Occur. Pilots are often unaware that monitoring performance has degraded.

8.3.3 Design of SOPs. SOPs may fail to explicitly address monitoring tasks.

8.3.4 Pilots' Inadequate Mental Model of Autoflight System Modes. Pilots may not have a complete or accurate understanding of all functions and behaviours of the autoflight system. Some aspects of automated systems for flightpath management are not well matched to human information processing characteristics.

8.3.5 Training. Training may overlook the importance of monitoring and how to do it effectively. Lack of emphasis on monitoring may occur in training and evaluation.

8.3.6 Pilot Performance. High workload, distraction, and inattention can all lead to monitoring errors.

In addition, human performance limitations should be acknowledged as potential challenges for effective monitoring. The human brain has difficulty with sustained vigilance and has quite limited ability to multitask. Pilots are vulnerable to interruptions and distractions and to cognitive limitations that affect what they notice and do not notice.

It can be difficult for humans to monitor for errors and deviations on a continuous basis when errors and deviations rarely occur. This is true for the range of workload conditions experienced by the flightcrew members. Monitoring during high-workload periods is important since these periods present situations in rapid flux and because high workload increases vulnerability to error. However, studies show that poor monitoring performance can be present during low-workload periods as well. Lapses in monitoring performance during lower-workload periods are often associated with boredom, complacency, or both.

8.4 **Defining Pilot Monitoring Duties.** In a two-pilot operation, one pilot is designated as PF and one pilot is designated as PM. A review of operators' manuals indicates that the roles and associated tasks of the PF and PM are not always clearly defined. Each operator should explicitly define the roles of the PF and PM to include:

1. At any point in time during the flight, one pilot is the PF and one pilot is the PM.

2. The PF is responsible for managing, and the PM is responsible for monitoring the current and projected flightpath and energy of the aircraft at all times.

3. The PF is always engaged in flying the aircraft (even when the aircraft is under AP control) and avoids tasks or activities that distract from that engagement. If the PF needs to engage in activities that would distract from aircraft control, the PF should transfer aircraft control to the other pilot, and then assume the PM role.

4. Transfer of PF and PM roles should be done positively with verbal assignment and verbal acceptance to include a short brief of aircraft state.

5. The PM supports the PF at all times, staying abreast of aircraft state and ATC instructions and clearances.

6. The PM monitors the aircraft state and system status, calls out any perceived or potential deviations from the intended flightpath, and intervenes if necessary.

7. The PF provides a briefing to a pilot returning from a break. The briefing should include appropriate information to ensure the pilot returning from the break is updated on aircraft and systems states and current ATC instructions and assignments.

8.5 **Operational Policies and Procedures.** Operational policies and procedures should be reviewed or developed to ensure the division of duties and responsibilities between flight crew members protects the ability of the PF to control the flightpath. Assigning non-flightpath-related tasks to the PF should generally be avoided. Operational data should be collected and used to revise definitions of PF and PM roles and responsibilities to ensure their effectiveness. Operators are encouraged to take an integrated approach in operations and training (e.g., initial and recurrent) to emphasize the responsibilities and importance of PF and PM roles.

A critical aspect of monitoring duties includes intervention when a deviation is identified. Each operator's policies, procedures, and training should adequately cover flightpath intervention including human-to-human intervention.

8.6 **Intervention Strategies.**

8.6.1 What Intervention Strategies Should Include. Intervention assumes an actual, or potential, problem has been detected. Effective PM can help detect a problem, which is necessary before intervention can begin. This is an important point since the pilot cannot intervene unless a condition requiring intervention is correctly recognized. If the monitoring activity is successful (problematic condition is recognized) then the pilot must know what intervention is appropriate for that situation.

Policies and procedures for expected interventions should be established and include:

1. Deviation parameters;
2. Required callouts; and
3. Conditions for takeover.

8.6.2 Human-to-Human Intervention. If a flightpath problem occurs, the PM should notify the PF about the problem and expect that the PF will then correct the problem. One way for the PM to accomplish notifying the PF is to verbalize a deviation callout followed by an expected response from the PF to that callout with corrective action.

8.6.2.1 SOPs should indicate what to say, how to say it, when to say it, and with what level of appropriate assertiveness. SOPs should also address if or when the
PM should take over the PF role if it is determined that the PF is not correcting the flightpath problem in a timely manner. Considerations for the decision to take over control should include subtle incapacitation or no response or flightpath correction after two challenges. The SOP should also specify what the specific callouts and associated actions are required with a takeover to ensure a positive exchange of aircraft control occurs. Policies must be clear to ensure there is no confusion over who is PF at any time.

8.6.2.2 Similarly, SOPs should describe how the PF notifies the PM about a flight guidance issue. For example, in some operations, if the AP is off with the flight director (FD) on, the PF hand-flies the aircraft, but the PM makes all flight guidance inputs. In this situation, consider the case where the PM makes an erroneous flight guidance input, and the PF notices it. In this case, Human-to-Human intervention would involve the PF verbalizing to the PM the error and desired correction. (e.g., "approach mode still isn't armed – arm approach, please."). To capture all of this, the recommendation wording may be something like: "PM communicating effectively to the PF about the flightpath problem, expecting that the PF will then correct the problem, or the PF communicating to the PM about a flight guidance problem (if the PM is responsible for flight guidance inputs), expecting that the PM will correct that problem."

8.6.2.3 Another example is where a PM calls "1-dot high" and the PF responds with "correcting" and returns to glide path in a timely manner. If, for example, the PF does not respond to two successive challenges, then, per operator's SOP, if safety indicates, the PM calls "I have control, going around" and initiates a go around as PF.

Note: Flightpath control is the responsibility of the PF, whereas flightpath guidance may be the responsibility of either pilot, depending on the operator's SOPs.

8.7 Training for PM. An operator should train its pilots on all policies and procedures related to monitoring the flightpath (e.g., callouts, double-pointing, etc.). This training should also include any of the operator's recommended practices.

1. Pilots should be trained on the responsibilities of the PM to monitor the flightpath. In particular, pilots should be trained to recognize when the PF is not adequately controlling the flightpath or when the PM is not adequately monitoring the flightpath. This training should include pilot task loading and signs of diminished performance. Some examples include lack of communication, channelized attention, and failure to make required callouts.

2. Pilots should be trained on applicable common errors in monitoring the flightpath. This includes training on appropriate methods of recognizing precursors to, and signs of, degraded monitoring and on resolving monitoring errors and/or lapses.

3. Pilots should be trained on the concept that there are predictable situations during each flight when the risk of a flightpath deviation is increased, heightening the importance of proper task/workload management. If the PM is trained to recognize the flight phases or situations

when they are most vulnerable to flightpath deviations (including when little time exists to correct deviations), he or she could strategically plan tasks and workload to maximize monitoring during those phases.

4. Pilots should be trained on CRM/threat and error management (TEM) principles and human performance vulnerabilities related to monitoring, the importance of monitoring, and the operator approved practices that achieve effective monitoring of the flightpath.

5. Pilots should be trained on system failures that may distract from effective monitoring and proper flightpath management.

6. Pilots should be trained to manage distractions that interfere with monitoring the flightpath. Provide guidance on managing task priorities and train them to effectively switch between other tasks and monitoring of the flightpath so that flightpath vigilance is always maintained. Include information and task management strategies that enable pilots to use charts, EFB, ACARS, etc. while also effectively monitoring the flightpath and airplane energy state.

7. Pilots should be trained on intervention methods that the PM can use to help the PF regain proper control of the flightpath and provide opportunities for the PM to practice these methods (e.g., calling out deviations, levels of assertiveness).

8. Pilots should be trained on and be able to demonstrate understanding of operationally relevant combinations/levels of flight guidance and flight control automation (e.g., given a certain set of circumstances, what will happen next?).

9. Ensure pilots can transition seamlessly between combinations/levels of flight guidance/flight control automation (including manual flight) by training them to anticipate, recognize, and recover from known flight guidance (includes Flight Management System (FMS)) and flight control (includes AP and, autothrottles) system-behavioural challenges (e.g., subtle mode reversions), and environmental/ circumstantial traps that are known to lead to flightpath-related errors (e.g., vectors off, then back on, a Standard Terminal Arrival Route (STAR) during a "descend via" clearance).

10. Flight guidance and flight control systems training should include an assessment of a pilots understanding of those systems and what will happen
'next' given a certain set of flight circumstances, and the reasons why. The training should incorporate FMS degradations and failures and operational consequences requiring flight crew action, known flight guidance and flight control system-behavioural challenges (e.g., subtle mode reversions), and environmental/circumstantial traps (e.g., vectors off, then back on, a STAR during a "descend via" clearance) that are known to lead to flightpath-related errors.

8.8 Incorporate Monitoring into SOPs. Monitoring performance can be significantly improved by: (1) developing and implementing effective SOPs to support monitoring and cross-checking functions, and appropriate interventions, (2) by training crews on monitoring strategies, and (3) by pilots following those SOPs and strategies.

If not designed appropriately, some SOPs may actually detract from effective monitoring. For example, one operator required a passenger address (PA) announcement when climbing and descending through 10,000 feet. This requirement had the unintended effect of "splitting the flight deck" at a time when frequency changes and new altitude clearances were likely. When the operator reviewed its procedures it realized that this procedure detracted from having both pilots "in the loop" at a critical point and consequently decided to eliminate it. Operators should review existing SOPs and modify those that can detract from monitoring.

8.9 Autoflight Considerations.

8.9.1 Autoflight Mode Confusion. Safety data (including accident, incidents, Line Operations Safety Audit (LOSA), FOQA, and ASAP data) have shown that autoflight mode confusion is a potential vulnerability in flight operations and merits special attention during monitoring tasks. Pilots should be able to demonstrate the knowledge and skill necessary to correctly select, interpret, and anticipate normal autoflight modes as well as be able to demonstrate appropriate remedial actions for inappropriate or unexpected autoflight modes. This should include the ability to:

1. Correctly identify and interpret individual flight mode annunciations;

2. Describe the respective mode's impact on the related systems and airplane operation; and

3. Understand pitch mode annunciations and their relationship to available thrust as well as the aircraft's energy state (e.g. the risk of using vertical speed mode to climb at high altitudes with limited available thrust).

8.9.1.1 Equipment and operator culture may influence how mode awareness protocols are designed and implemented. Therefore, an operator should create mode awareness procedures that reflect the equipment and how the operator
employs the equipage and train/assess the procedures. When formulating mode awareness SOPs, consider the following:

1. When to require verbal callouts of mode status and changes, keeping in mind workload during specific phases of flight, pilot tasks, and unanticipated mode changes;

2. Operators should describe the mode confirmation methodology for the PF/PM roles. It is important that an operator's procedures for mode confirmation take into account differences in phases of flight, pilot tasks, and high workload situations.

3. One example is briefing current autoflight mode status to any pilot that is returning to a pilot seat after a physiological break or distraction from flying (communicating with dispatch, flight attendant, etc.). Following a distraction,

4. pilots should discuss flight deck status. For a pilot that is returning to a pilot seat after a break, develop a formal briefing that is appropriate for the equipment with required items to ensure the pilot is updated on systems status.

5. Create phase of flight procedures/dialog boxes (for example: takeoff, climb, cruise, descent, approach) that include mode changes and indications for each level of automation allowed.

6. Include mode change indication in manoeuvre procedures/dialog boxes. When possible, associate callout names and timing to match mode changes. For example, some operators have implemented operator standard procedures such as "Confirm, Activate, Monitor, Intervene (CAMI)," or "Verbalize, Verify, and Monitor (VVM)," or similar systems, or even variations thereof. Such procedures provide the flightcrew with a structured method to conduct operations within the flight deck that help to trap errors. Regardless of the form of the strategy, the objective is to ensure that everyone in the flight deck understands the active mode, the effects of the newly engaged mode, and

7. skillfully reacts to ensure the aircraft trajectory and energy remains as desired. Some effects of input and selection are delayed (e.g., armed to active) and latent errors may not become apparent until some time has passed.

8. Verification of intended path/functions and awareness of modes is important throughout all phases of flight, including ground operations.

8.9.2 Autoflight Mode Awareness. The Flight Mode Annunciator (FMA) provides the flight crew with information on the status of the autoflight/automated systems, specifically with respect to the guidance and control functions being utilized. Whether manually controlling the aircraft, using the automated systems to control the aircraft flightpath and energy, or various combinations of both, the FMAs are the information source for depicting "who is doing what."

8.9.2.1 It is important that flight crews are thoroughly trained to understand the implications and relationships of each mode since the respective mode communicates the source of the aircraft flightpath and energy. It is also imperative that both crewmembers, as a team, understand the current mode status and its controlling system to effectively manage flightpath and energy. Just as the monitoring function is the concurrent responsibility of both pilots (and potential auxiliary crews when in the flight deck), awareness of the FMAs and their affects are also the duty of both pilots. Understanding the consequences of modes, either expected or unanticipated, and the ability to anticipate subsequent modes and the comprehension of the significance and system effects of the mode is central to flightpath management.

8.9.2.2 Autoflight system mode awareness requires effective monitoring of autoflight modes. Below are a few strategies that could be trained to improve monitoring of the autoflight modes:

1. Stay in the loop by mentally flying the aircraft even when the AP or other pilot is flying the aircraft.

2. When you have been distracted, ensure that you always check the FMAs and your flight instruments to get back in the loop as soon as possible.

3. Monitor the flight instruments just as you would when you are manually flying the aircraft.

4. Be diligent in monitoring all flightpath changes – pilot actions, system modes, aircraft responses.

5. Always make monitoring of the PF a priority task when flightpath changes are being made.

6. Always check the FMA after a change has been selected on the AP mode control panel.

7. Maintain an awareness of the autoflight systems and modes selected by the crew or automatically initiated by the flight management computer (mode awareness) to effectively monitor flightpath.

8. Maintain an awareness of the capabilities available in engaged autoflight modes to avoid mode confusion.

9. Effectively monitor systems and selected modes to determine that the aircraft is on the desired flightpath.

CHAPTER 9: FLIGHT SIMULATION TRAINING DEVICE (FSTD) CONSIDERATIONS

9.1. 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.

9.2. FSTD EVALUATION RECOMMENDATIONS

a. It is highly recommended that all FSTDs being used for Upset Prevention and recovery (UPRT) manoeuvres be specifically evaluated for such manoeuvres.

9.3. 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 manoeuvres. This may include video and audio capability, preprogramed distractors/initiators, as well as feedback tools to determine if the recovery manoeuvre 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., subthreshold 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,
- Manoeuvreing speed,
- Flap extended speed,
- Minimum control speed,
- Landing gear speeds,
- Rough air speed,
- Altitude limitations,
- Power plant limitations, and
- Manoeuvreing 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 the Airplane Upset Recovery Training Aid (AUPRT)-Rev3 for additional information.

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 manoeuvre 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.

9.4. 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 manoeuvres until the trainee is proficient.

9.5 Additional Simulator Qualification Requirements for Stall, Upset Prevention and Recovery, and Engine and Airframe Icing Training Tasks

9.5.1 High Angle of Attack Model Evaluation

1. **Applicability:** This attachment applies to all simulators that are used to satisfy training requirements for stall manoeuvres that are conducted at angles of attack beyond the activation of the stall warning system. This attachment is not applicable for those FSTDs that are only qualified for approach to stall manoeuvres where recovery is initiated at the first indication of the stall.

2. **General Requirements:** The requirements for high angle of attack modeling are intended to evaluate the recognition cues and performance and handling qualities of a developing stall through the stall identification angle-of-attack and recovery. Strict time- history-based evaluations against flight test data may not adequately validate the aerodynamic model in an unsteady and potentially unstable flight regime, such as stalled flight. As a result, the objective testing requirements do not prescribe strict tolerances on any parameter at angles of attack beyond the stall identification angle of attack. In lieu of mandating such objective tolerances, a Statement of Compliance (SOC) will be required to define the source data and methods used to develop the stall aerodynamic model.

3. **Fidelity Requirements:** The requirements defined for the evaluation of full stall training manoeuvres are intended to provide the following levels of fidelity:

   a. Airplane type specific recognition cues of the first indication of the stall (such as the stall warning system or aerodynamic stall buffet);
   b. Airplane type specific recognition cues of an impending aerodynamic stall; and
   c. Recognition cues and handling qualities from the stall break through recovery that are sufficiently exemplar of the airplane being simulated to allow successful completion of the stall recovery training tasks.

For the purposes of stall manoeuvre evaluation, the term “exemplar” is defined as a level of fidelity that is type specific of the simulated airplane to the extent that the training objectives can be satisfactorily accomplished.

4. **Statement of Compliance (Aerodynamic Model):** At a minimum, the following must be addressed in the SOC:

a. **Source Data and Modelling Methods:** The SOC must identify the sources of data used to develop the aerodynamic model.

Of particular interest is a mapping of test points in the form of alpha/beta envelope plot for a minimum of flaps up and flaps down aircraft configurations. For the flight test data, a list of the types of manoeuvres used to define the aerodynamic model for angle of attack ranges greater than the first indication of stall must be provided per flap setting. In cases where it is impractical to develop and validate a stall model with flight-test data (e.g., due to safety concerns involving the collection of flight test data past a certain angle of attack), the data provider is expected to make a reasonable attempt to develop a stall model through the required angle of attack range using analytical methods and empirical data (e.g., wind-tunnel data);

b. **Validity Range:** The FSTD operator must declare the range of angle of attack and sideslip where the aerodynamic model remains valid for training. For stall recovery training tasks, satisfactory aerodynamic model fidelity must be shown through at least 10 degrees beyond the stall identification angle of attack. For the purposes of determining this validity range, the stall identification angle of attack is defined as the angle of attack where the pilot is given a clear and distinctive indication to cease any further increase in angle of attack where one or more of the following characteristics occur:

i. No further increase in pitch occurs when the pitch control is held at the full aft stop for 2 seconds, leading to an inability to arrest descent rate;
ii. An uncommanded nose down pitch that cannot be readily arrested, which may be accompanied by an uncommanded rolling motion;
iii. Buffeting of a magnitude and severity that is a strong and effective deterrent to further increase in angle of attack; and
iv. Activation of a stick pusher.

The model validity range must also be capable of simulating the airplane dynamics as a result of a pilot initially resisting the stick pusher in training. For aircraft equipped with a stall envelope protection system, the model validity range must extend to 10 degrees of angle of attack beyond the stall identification angle of attack with the protection systems disabled or otherwise degraded (such as a degraded flight control mode as a result of a pitot/static system failure).

c. **Model Characteristics:** Within the declared range of model validity, the SOC must address, and the aerodynamic model must incorporate, the following stall characteristics where applicable by aircraft type:

i. Degradation in static/dynamic lateral-directional stability;
ii. Degradation in control response (pitch, roll, yaw);
i. Uncommanded roll acceleration or roll-off requiring significant control deflection to counter;
iv. Apparent
iv. Apparent randomness or non-repeatability;
v. Changes in pitch stability;
vi. Stall hysteresis;
vii. Mach effects; viii. Stall buffet; and
ix. Angle of attack rate effects.

An overview of the methodology used to address these features must be provided.

5. Statement of Compliance (Subject Matter Expert Pilot Evaluation):
The FSTD operator must provide an SOC that confirms the FSTD has been subjectively evaluated by a subject matter expert (SME) pilot who is knowledgeable of the aircraft's stall characteristics. In

order to qualify as an acceptable SME to evaluate the FSTD's stall characteristics, the SME must meet the following requirements:

a. Has held a type rating/qualification in the aircraft being simulated;

b. Has direct experience in conducting stall manoeuvres in an aircraft that shares the same type rating as the make, model, and series of the simulated aircraft. This stall experience must include hands on manipulation of the controls at angles of attack sufficient to identify the stall (e.g., deterrent buffet, stick pusher activation, etc.) through recovery to stable flight;

c. Where the SME's stall experience is on an airplane of a different make, model, and series within the same type rating, differences in aircraft specific stall recognition cues and handling characteristics must be addressed using available documentation. This documentation may include aircraft operating manuals, aircraft manufacturer flight test reports, or other documentation that describes the stall characteristics of the aircraft; and

d. Must be familiar with the intended stall training manoeuvres to be conducted in the FSTD (e.g., general aircraft configurations, stall entry methods, etc.) and the cues necessary to accomplish the required training objectives. The purpose of this requirement is to ensure that the stall model has been sufficiently evaluated in those general aircraft configurations and stall entry methods that will likely be conducted in training.

This SOC will only be required once at the time the FSTD is initially qualified for stall training tasks as long as the FSTD's stall model remains unmodified from what was originally evaluated and qualified.

a. An assessment of pilot availability that demonstrates that a suitably qualified pilot
b. meeting the experience requirements of this section cannot be practically located; and
c. Alternative methods to subjectively evaluate the FSTD's capability to provide the stall recognition cues and handling characteristics needed to accomplish the training objectives.

9.5.2 Upset Prevention and Recovery Training (UPRT) Manoeuvre Evaluation

1. **Applicability:**This attachment applies to all simulators that are used to satisfy training requirements for upset prevention and recovery training (UPRT) manoeuvres. For the purposes of this attachment (as defined in the Airplane Upset Recovery Training Aid), an aircraft upset is generally defined as an airplane unintentionally exceeding the following parameters normally experienced in line operations or training:

   a. Pitch attitude greater than 25 degrees nose up;

   b. Pitch attitude greater than 10 degrees nose down;

   c. Bank angles greater than 45 degrees; and

   d. Within the above parameters, but flying at airspeeds inappropriate for the conditions. FSTDs that will be used to conduct training manoeuvres where the FSTD is eitherrepositioned into an aircraft upset condition or an artificial stimulus (such as weather phenomena or system failures) is applied that is intended to result in a flightcrew entering an aircraft upset condition must be evaluated and qualified in accordance with this section.

2. General Requirements: The general requirements for UPRT qualification include three basic elements required for qualifying an FSTD for UPRT Manoeuvres:

a. **FSTD Training Envelope**: Valid UPRT should be conducted within the high and moderate confidence regions of the FSTD validation envelope as defined in paragraph 3 below.

b. **Instructor Feedback**: Provides the instructor/evaluator with a minimum set of feedback tools to properly evaluate the trainee's performance in accomplishing an upset recovery training task.

c. **Upset Scenarios**: Where dynamic upset scenarios or aircraft system malfunctions are used to stimulate the FSTD into an aircraft upset condition, specific guidance must be available to the instructor on the IOS that describes how the upset scenario is driven along with any malfunction or degradation in FSTD functionality that is required to stimulate the upset.

3. FSTD Validation Envelope: For the purposes of this attachment, the term "flight envelope" refers to the entire domain in which the FSTD is capable of being flown with a degree of confidence that the FSTD responds similarly to the airplane. This envelope
can be further divided into three subdivisions (see Appendix 3-D of the *Airplane Upset Recovery Training Aid*):

a. Flight test validated region

This is the region of the flight envelope which has been validated with flight test data, typically by comparing the performance of the FSTD against the flight test data through testsincorporated in the QTG and other flight test data utilized to further extend the model beyond the minimum requirements. Within this region, there is high confidence that the simulator responds similarly to the aircraft. Note that this region is not strictly limited to what has been tested in the QTG;as long as the aerodynamics mathematical model has been conformed to the flight test results, that portion of the mathematical model can be considered to be within the flight test validated region.

b. Wind tunnel and/or analytical region

This is the region of the flight envelope for which the FSTD has not been compared to flight test data, but for which there has been wind tunnel testing or the use of other reliable predictive methods (typically by the aircraft manufacturer) todefine the aerodynamic model. Any extensions to the aerodynamic model that have been evaluated in accordance with the definition of an exemplar stall model (as described in the stall manoeuvre evaluation section) must be clearly indicated. Within this region, there is moderate confidence that the simulator will respond similarly to the aircraft.

c. Extrapolated: This is the region extrapolated beyond the flight test validated and wind

d. Tunnel/analytical regions. The extrapolation may be a linear extrapolation, a holding of the last value before the extrapolation began, or some other set of values. Whether this extrapolated data is provided by the aircraft or simulator manufacturer, it is a "best guess" only. Within this region, there is low confidence that the simulator will respond similarly to the aircraft. Brief excursions into this region may still retain a moderate confidence level in FSTD fidelity; however, the instructor should be aware that the FSTD's response may deviate from the actual aircraft.

4. Instructor Feedback Mechanism: For the instructor/evaluator to provide feedback

to the student during UPRT manoeuvre training, additional information must be accessible that indicates the fidelity of the simulation, the magnitude of trainee's flight control inputs, and aircraft operational limits that could potentially affect the successful completion of the manoeuvre(s). At a minimum, the
following must be available to the instructor/evaluator:

a. FSTD Validation Envelope: The FSTD must employ a method to display the FSTD's expected fidelity with respect to the FSTD validation envelope. This may be displayed as an angle of attack vs sideslip (alpha/beta) envelope cross-plot on the Instructor Operating System (IOS) or other alternate method to clearly convey the FSTD's fidelity level during the manoeuvre. The cross-plot or other alternative method must display the relevant validity regions for flaps up and flaps down at a minimum. This validation envelope must be derived by the aerodynamic data provider or derived using information and data sources provided by the original aerodynamic data provider.

b. **Flight Control Inputs**: The FSTD must employ a method for the instructor/evaluator to assess the trainee's flight control inputs during the upset recovery manoeuvre. Additional parameters, such as cockpit control forces (forces applied by the pilot to the controls) and the flight control law mode for fly-by-wire aircraft, must be portrayed in this feedback mechanism as well. For passive sidesticks, whose displacement is the flight control input, the force applied by the pilot to the controls does not need to be displayed. This tool must include a time history or other equivalent method of recording flight control positions.

c. **Aircraft Operational Limits**: The FSTD must employ a method to provide the instructor/evaluator with real-time information concerning the aircraft operating limits. The simulated aircraft's parameters must be displayed dynamically in real-time and also provided in a time history or equivalent format. At a minimum, the following parameters must be available to the instructor:

i. Airspeed and airspeed limits, including the stall speed and maximum operating limit airspeed (Vmo/Mmo);
ii. Load factor and operational load factor limits; and
ii. Angle of attack and the stall identification angle of attack.

CHAPTER 10: ORGANIZATIONAL SAFETY INITIATIVES (ORG SEIS) AND OPERATIONAL SAFETY RISKS INITIATIVES (OPS SEIS)

10.1 In order to align RASG-AFI LOC-I initiatives with the 2020-2022 Edition of the ICAO Global Aviation Safety Plan (GASP), organizational and operational safety risks have been identified.

10.2 The identified Organizational challenges relate to safety enhancement initiatives (SEIs) to meet GASP goals, States' safety oversight capabilities, the implementation of SSPs, as well as industry's implementation of SMS.

10.3 The operational safety risks relate to SEIs to meet the GASP goals, continuous reduction of operational safety risks and regional and industry safety risk management activities to address LOC-I as a high-risk category of occurrences.

10.4 Two forms on Organizational Safety Initiatives have been established: ORG SEIs (including ORG-UPRT-SEIs and ORG-Additional-SEIs) and Operational safety risks Initiatives: OPS SEIs (including OPS-UPRT-SEIs and OPS-Additional-SEIs).

10.5 States and Industry should use these forms to report on progress made on each safety initiative in accordance with their areas of responsibility and applicability.

10.6 It is worth noting that an online survey had been previously been initiated but this survey did not factor in Organizational Safety Initiatives and Operational safety risks Initiatives in a comprehensive manner because it was done before the 2020-2022 Edition of the ICAO GASP. The corresponding links had been sent to States and other stakeholders.

10.7 ORG SEIs

ORG SEIs

1) ORG-UPRT- SEIs

No.	Action	Deliverable(s) Establishment/Implementation	OPS/ ORG	Responsibility	Progress made
1.	Transpose in specific operating regulations new SARPs on UPRT.	Amendments to PEL and OPS regulations	ORG	CAAs	
2.	Establish UPRT training programmes including training tasks.	UPRT training programmes including training tasks.	ORG	ATOs, AOs, IATA	
3.	Training of UPRT instructors and CAAs inspectors should be enhanced.	Training of UPRT instructors and CAAs inspectors	ORG	ATOs, AOs, CAAs	
4.	Provide on-airplane UPRT for a selected core group of instructors.	On-airplane UPRT for a selected core group of instructors	ORG	ATOs, AOs, CAAs, RSOOs	
5.	Upgrade current FSTDs to incorporate proper modelling of full flight envelope and instructor tools to provide feedback for pilot performance.	Refer to SEI UPRT ORG16	ORG	ATOs, AOs	
6.	Take into account smaller turboprop (non-swept wing) airplanes in UPRT.	To apply best practices (while waiting for ICAO to develop additional guidance material)	ORG	ATOs, AOs, CAAs, ICAO	
7.	Improve pilots aptitude testing and hiring processes and procedures.	Enhancement of pilots aptitude testing and hiring processes and procedures.	ORG	AOs	
8.	Harness assistance from airlines that have implemented UPRT, like Kenya Airways and South African Airways.	Best practices MoUs, MoCs	ORG	ICAO, ATOs, AOs, CAAs, RSOOs	
9.	Foster cooperation through regional organizations and regional economic communities.	-Regional arrangements -MoUs	ORG	Champion	
10.	Gain support from the industry and other stakeholders including insurance underwriters.	-Letters to Industry and other stakeholders for support - letters to Insurance underwriters for support	ORG	AFRAA, IATA, AOs	
11.	Promote champions for industry best practices.	Designation of Champions	ORG	Champion, AOs, CAAs	
12.	Share information on LOC-I and UPRT.	Processes and procedures for sharing of information established	ORG	Champion, All stakeholders	
13.	Build African capacity and expertise.	Refer to SEIs UPRT ORG 3 and 4	ORG	ATOs, AOs, CAAs, AFRAA, Champion	
14.	Establish a Regional UPRT training organization fitted, in particular, with adequate FSTDs.	-Letters to stakeholders -Inception	ORG	ATOs, AOs, CAAs, AFRAA, IATA, AATO	
15.	Establish a five years implementation plan for regulatory oversight of UPRT is essential.	five years implementation plan for regulatory oversight of UPRT	ORG	ICAO, Champion, CAAs	
16.	Update the established five years implementation plan for training means and provision of UPRT training	five years implementation plan for the establishment of training means and provision of training in UPRT updated	ORG	Champion, ATOs, AOs, IATA, CAAs	
17.	Continuous evaluation of the 5-year Plan	Periodic evaluations	ORG	Champion, CAAs	
18.	Evaluate the training gaps given the current curriculum for pilots and define priorities and sequencing for the training.	Training gaps and training priorities	ORG	ATOs, AOs, CAAs, IATA	
19.	Improve CAAs' approval systems for training organizations including simulators' approvals, training and procedures manual, quality systems and safety management systems.	Approval processes and procedures	ORG	CAAs	

No.	Action	Deliverable(s) Establishment/Implementation	OPS/ ORG	Responsibility	Progress made
20.	Improve approval of air operator training programmes including ensuring consistency of the applied one with air operator flight safety documents system.	Approval processes and procedures	ORG	CAAs	
21.	Take into account safety risks derived from flight data analysis and safety management systems for recurrent training.	UPRT training programmes including training tasks.	ORG	AOs, CAAs, IATA	

2) ORG-Add-SEIs

No.	Action	Deliverable(s) Establishment/Implementation	OPS/ ORG	Responsibility	Progress Made
1.	Promotion of countermeasures for other safety issues and contributory factors to LOC-I accidents.	-Correspondences -Information on best practices	ORG	Champion, ATOs, AOs, CAAs	
2.	Define beside the Abuja high level safety target of reducing LOC-I related accidents, subsidiary parameters in order to assess progress made in LOC-I implementation plan.	subsidiary target parameters for LOC-I	ORG	ICAO ESAF	
3.	Oversee proper implementation of flight crew duty limitation and fatigue risk management systems.	-Procedures for CAAs inspectors -Processes and procedures of the AOs	ORG	AOs, CAAs	
4.	Sensitize flight crew on effects of medications.	-Procedures for CAAs inspectors -Processes and procedures of the AOs	ORG	AOs, CAAs	
5.	Address LOC-I issues in managing cases of unlawful interference.	-Coordination -Procedures	ORG	AOs, CAAs, ICAO	
6.	Address LOC-I issues concerning air traffic management.	-Coordination -Procedures	ORG	AOs, CAAs, ICAO	
7.	Systematically report serious incidents and accidents.	Reporting processes and procedures	ORG	AOs, CAAs, AAIAs	
8.	Establish and implement a data collection system in the framework of an SMS.	Data collection system in the framework of an SMS.	ORG	AOs, CAAs	

Note: * The proposed dateline is tentative deadline to be coordinated with relevant stakeholders.	
CAAS: Civil Aviation Authorities	FOOs: Flight Operations Officers
AAIAs: Aviation Accident Investigation Authorities	CRM: Crew Resources Management
AATO: Association of Aviation Training Organizations	MoU: Memorandum of Understanding
ATOs: Aviation Training Organizations	MoC: Memorandum of Cooperation
AOs: Air Operators	AOC: Air Operator Certificate
ANSPs: Air Navigation Service Providers	SMS: Safety Management System
FSTDs: Flight Simulation Training Devices	

10.8 OPS SEIs

OPS SEIs

1) OPS-UPRT-SEIs

No.	Action	Deliverable(s) Establishment/Implementation	OPS/ ORG	Responsibility	Progress Made
22.	Standardize training and avoid negative training.	Standardized training	OPS	ATOs, AOs, CAAs, AATO, CASSOA	
23.	Train for proficiency and avoid checking for UPRT.	-Amendments to PEL and OPS regulations (for CAAs) -Training of UPRT instructors and CAAs inspectors	OPS	ATOs, AOs, CAAs	
24.	Consider that startle can only be rendered on on-airplane training.	Inclusion of startle factor by providing minimum on-airplane training	OPS	ATOs, AOs, CAAs	
25.	Take into account smaller turboprop (non-swept wing) airplanes in UPRT.	To apply best practices (while waiting for ICAO to develop additional guidance material)	OPS	ATOs, AOs, CAAs, ICAO	
26.	Establish adequate operational control for relevant training organizations.	-Operational control organization, means, processes and procedures for ATOs - Inspectors procedures for CAAs	OPS	ATOs, CAAs	
27.	Address all type of stalls including tail stall.	UPRT training programmes including training tasks.	OPS	ATOs, AOs	
28.	Training for high speed stall as a priority.	UPRT training programmes including training tasks	OPS	ATOs, AOs	
29.	Strike a balance between use of automation and stick and rudder.	UPRT training programmes including training tasks	OPS	ATOs, AOs	
30.	Properly address UPRT in CRM training.	Inclusion of UPRT in CRM training	OPS	AOs	
31.	Evaluate the impact of training on special operations related to the AOC and make necessary enhancements to take into account UPRT.	Approval processes and procedures	OPS	CAAs	
32.	Assess aircraft capabilities and limitations for on-airplane training.	ATO approval Procedures	OPS	ATOs, AOs, CAAs	
33.	Avoid using multi-engine airplane for on-airplane training.	ATO approval Procedures	OPS	ATOs, AOs, CAAs	
34.	Aircraft upset prevention recovery training in all full flight simulator type conversion and recurrent training programmes	ATO approval Procedures Air operator training programme approval	OPS	CAAs /ATOs, AOs	
35.	More time devoted to training multi-crew pilots for the monitoring role	Air operator Training programme; approval	OPS	CAAs ATOs, AOs	
36.	Promote bank angle alerting systems into all multi-engine aircraft	Training programme	OPS	ATOs, AOs	
37.	Training on manual aircraft handling of approach to stall and stall recovery (including at high altitude)	Training programme	OPS	ATOs, AOs	
38.	Recurrent training on flight mechanics	Training programme	OPS	ATOs, AOs	
39.	Simulator fidelity	Training programme	OPS	ATOs, AOs	
40.	Training and procedures to address Distractions	Training programme	OPS	CAAs /ATOs, AOs/RASG-AFI	
41.	Training factoring Adverse weather	Training programme	OPS	CAAs/ATOs, AOs/RASG-AFI	

No.	Action	Deliverable(s) Establishment/Implementation	OPS/ ORG	Responsibility	Progress Made
42.	**Training factoring Complacency**	**Training programme**	**OPS**	**CAAs/ATOs, AOs/RASG-AFI**	
43.	**Procedures for adequate SOPs for effective flight management**	**Training programme Operations manual**	**OPS**	**CAAs/ATOs, AOs/RASG-AFI**	
44.	**Training and procedures addressing Insufficient height above terrain for recovery**	**Training programme**	**OPS**	**CAAs/ATOs, AOs/RASG-AFI**	
45.	**Training and procedures addressing Lack of awareness of or competence in procedures for recovery from unusual aircraft attitudes**	**Training programme**	**OPS**	**CAAs/ATOs, AOs/RASG-AFI**	
46.	**Training and procedures addressing Inappropriate flight control inputs in response to a sudden awareness of an abnormal blank angle**	**Training programme**	**OPS**	**CAAs/ATOs, AOs/RASG-AFI**	

2) OPS-Add-SEIs

No.	Action	Deliverable(s) Establishment/Implementation	OPS/ ORG	Responsibility	Progress Made
9.	Analyze in-flight incapacitation events and medical findings during medical assessments to identify areas of increased medical risk	-Procedures for designated medical examiners -Procedures for CAAs medical assessors -Processes and procedures of the AOs	OPS	AOs, CAAs	
10	Establish adequate operational control and flight planning for the air operators.	-Procedures for air operators certification and surveillance by CAAs -Adequate air operators organization for operational control and flight planning	OPS	AOs, CAAs	
11	Properly train flight operational officers/flight dispatchers.	-Training programmes for FOOs -Procedures for approval of training programmes for FOOs, instructors and examiners	OPS	AOs, CAAs	
12	Establish and implement procedures for the carriage of dangerous goods.	-Procedures for dangerous goods	OPS	AOs, CAAs	
13	Properly address and in a timely manner airworthiness/maintenance issues relating to critical parts/components/systems of the airplanes.	-Identification of critical parts/components/systems of the airplanes -Inclusion in the SMS	OPS	ATOs, AOs, CAAs	
14	Establish and implement routine and non-routine weather reporting procedures.	-Procedures for the approval of the operations manual	OPS	AOs, CAAs	
15	Improve ground-based communications for weather reporting by meteorological stations.	Improvement of ground-based communications for weather reporting by meteorological stations	OPS	CAAs, ANSPs	

Note: * The proposed dateline is tentative deadline to be coordinated with relevant stakeholders.	
CAAS: Civil Aviation Authorities	FOOs: Flight Operations Officers
AAIAs: Aviation Accident Investigation Authorities	CRM: Crew Resources Management
AATO: Association of Aviation Training Organizations	MoU: Memorandum of Understanding
ATOs: Aviation Training Organizations	MoC: Memorandum of Cooperation
AOs: Air Operators	AOC: Air Operator Certificate
ANSPs: Air Navigation Service Providers	SMS: Safety Management System
FSTDs: Flight Simulation Training Devices	

CHAPTER 11: FLIGHT DATA ANALYSIS (FDA)/SAFETY MANAGEMENT SYSTEMS (SMS)

11.1 Selected flight parameters should be relevant and appropriate to reflect the safety, quality or risk level of the process thereby providing a performance track.

11.2 For the processing of data, various methods can be used, among which: Exceedance detection, Routine measurements and Incident investigation.

11.3 Exceedance detection, includes such as deviations from flight manual limits, SOPs, or a set of core events/parameters. Table 11.3 displays typical sample parameters from the FRD relating to LOC-I.

11.4 For Routine measurements, data can be retained from all flights, not just those producing significant events. A selection of parameters is retained that is sufficient to characterize each flight and allow a comparative analysis of a wide range of operational variability. Emerging trends and tendencies are monitored before the trigger levels associated with exceedances are reached.

11.5 As for Incident investigation: the operator's SMS should define the events that need to be investigated and FDAPs provide valuable information for incident investigations and for follow-up of other technical reports. Table 11.5 shows typical examples of incidents relating to LOC-I.

Table 11.3

FLIGHT DYNAMICS/ AIRCRAFT HANDLING	**Excessive roll attitude or roll rate Excessive pitch angle Excessive bank angle Inadequate aircraft attitude Stall protection trigger Legitimate stall warning activation Excessive speed / vertical speed /acceleration Legitimate overspeed warning Inappropriate cruise altitude Envelope protection systems Inappropriate rate of climb Excessive cabin altitude Performance of ACAS RA manoeuvres (rate of climb/descent, altitude deviation)**
AIRCRAFT ENERGY	**Insufficient energy at high altitude Loss of lift Loss of thrust Height loss during take-off or go-around Inadequate aircraft energy**
AUTOMATION	**Autopilot self-disconnect events Mismanagement of automation**
AIRCRAFT MALFUNCTION	**Engine failure Instrument Malfunction Structural Failure Hardware failure Flight control failure or ineffective Inconsistencies of engine parameters**
AIRCRAFT SYSTEMS	**Fire, smoke and fumes Pressure System Malfunction or misuse High Cabin altitude Oxygen issues De-icing system failure**
AIRCRAFT PERFORMANCE	**CG out of limits Special Operations Incorrect performance calculation Overweight takeoff Low go-around or rejected landing Fuel exhaustion**
HUMAN FACTORS	**Abnormal flight control inputs Incorrect aircraft configuration Inappropriate use of rudder in jet aircraft**
WEATHER	**Adverse Weather Windshear Severe turbulence Icing conditions**

Table 11.5

Gross failures to achieve predicted performance during take-off or initial climb.
Fires and/or smoke in the cockpit, in the passenger compartment, in cargo compartments or engine fires, even though such fires were extinguished by the use of extinguishing agents.
Events requiring the emergency use of oxygen by the flight crew.
Aircraft structural failures or engine disintegrations, including uncontained turbine engine failures, not classified as an accident.
Multiple malfunctions of one or more aircraft systems seriously affecting the operation of the aircraft.
Flight crew incapacitation in flight
Fuel quantity level or distribution situations requiring the declaration of an emergency by the pilot, such as insufficient fuel, fuel exhaustion, fuel starvation, or inability to use all usable fuel on board.
System failures (including loss of power or thrust), weather phenomena, operations outside the approved flight envelope or other occurrences that caused or could have caused difficulties controlling the aircraft.
Failures of more than one system in a redundancy system mandatory for flight guidance and navigation.

CHAPTER 12: IN-FLIGHT INCAPACITATION AND CREW RESOURCE MANAGEMENT

12. 1 FLIGHT CREW INCAPACITATION

Flight crew incapacitation is a real safety hazard that occurs more frequently than many of the other emergencies. Incapacitation can occur in many forms. Sometimes the flight crew does not have any symptom before incapacitation. Incapacitation can occur in all age groups and during any phase of flight. Incapacitation may be either obvious or subtle, so it is important to remain alert for either. If the cockpit is managed in a disciplined manner in compliance with operating procedures, then a procedural deviation might very well be the first indication of pilot incapacitation. Obvious incapacitation is generally easy to detect and more likely to be of a prolonged nature. Subtle incapacitation is considered a more significant operational hazard because it may go undetected.

In order to help with the early detection of flight crew incapacitation, the Crew Resource Management (CRM) principles should be applied: - Correct crew coordination that involves routine monitoring and aural crosschecks. The absence of standard callouts at the appropriate time may indicate incapacitation of one flight crewmember - If one flight crewmember does not feel well, he must inform the other flight crewmember. Other symptoms like for example, incoherent speech, a pale and (or) fixed facial expression, or irregular breathing, may indicate the beginning of incapacitation.

12.2 HUMAN FACTORS

According to ICAO Doc 10011, Human Factors training as applied to UPRT comprise the following items:

1. Threat and error management (TEM)
2. Human information processing
3. Crew resource management (CRM)

4. Situation awareness
5. Decision-making
6. Problem-solving
7. Startle and stress response
8. Physiological factors.

In this guidance, CRM will be considered as practical way to apply human factors, including the above items.

More emphasis should be put on CRM training as mitigation means for LOC-I in case one member of the flight crew become incapacitated inflight, especially in the context of COVID-19.

12.3 CREW RESOURCE MANAGEMENT

12.3.1 Background

Briefly defined, crew resource management (CRM) is the effective use of all available resources, i.e. Equipment, procedures and people, to achieve safe and efficient flight operations.
Generally, CRM training is but one practical application of Human Factors. It should focus on the functioning of the flight crew as an intact team, not simply as a collection of technically competent individuals; and should provide opportunities for crew members to practice their skills together in the roles they normally perform inflight. The programme should teach crew members how to use their own personal and leadership styles in ways that foster crew effectiveness. Crew members' behaviour during normal, routine circumstances can have a powerful impact on how well they function during high-workload and stressful situations.
During critical emergency situations, basic skills and knowledge come into play, and it is unlikely that any crew member will be able to take the time to reflect upon his or her CRM training to determine how to act. Similar situations experienced in training increase the probability that a crew will handle actual stressful situations more competently. Research studies from the behavioural sciences strongly suggest that behavior change in any environment cannot be accomplished in a short period of time. Line crew need training time, awareness, practice and feedback, and continual reinforcement to learn lessons that will long endure.
When advancing from CRM Principles to CRM Procedures, most airlines emphasize CRM principles in the form of topics or markers. These principles include topics such as crew coordination, decision making, and situation awareness. These principles are in the form of recommended practices, and crews are encouraged to implement these practices when and how they see fit. The resulting behavior is not always predictable, and most airlines have found it difficult to specify standards of performance for CRM principles.
Advanced CRM (ACRM) is directed to the training and assessment of CRM skills within crew training programs. CRM procedures become a focal point in CRM training, and those procedures allow crew to practice specific CRM behaviors both in normal and non-normal situations. The procedures help crewmembers develop a consistent pattern of crew coordination allowing crew to know what to expect from each other. The CRM procedures also serve as a constant reminder to the importance of CRM within the operational environment. CRM procedures are an integral part of SOP, and may be integrated within briefings, checklists, and emergency or abnormal procedures, such as those found in a QRH, the FSM, or the FCOM.

12.3.2 What is CRM – Brief Descriptions

Cooperation: Each crewmember backs up the other which results in increased error avoidance, detection, and mitigation. Teamwork enables crew to do better "task work". Synergy – leads to better performance when working as one crew. It is important to establish the "crew shell" and prioritize WHAT is right –not WHO is right.

Cooperation Red Flags; Lack of support, One person does not back up another in high workload situations, Inadequate leadership, Failure to delegate tasks, Group pressure to conform, Lack of aircraft discipline, Not following SOPs, Questions discouraged, Conflicting opinions quashed
Five Strategies for an Effective Team; Maintain a clear mission, Maintain team expectations, Communicate with all team members, Maintain trust , Pitch in

Conflict Resolution: consciously set objectives, Clarify expectations, maintain the right tone by:- encouraging input, assertively communicating, actively listening, adhere to SOPs

Inflight conflicts: is the problem related to the immediate safety of the flight? If yes -Are you the PIC? If yes - Actively listen to your crew and provide feedback,
Is the problem related to the immediate safety of the flight? If no – Avoid the conflict. Are you the PIC? If no - Advocate your position clearly until the PIC provides feedback.

Leadership and Managerial Skills: Outline – Leadership, Authority and assertiveness, Managing workload, Planning and coordinating, Maintaining standard.
Leadership /followership involves exercising your rights, obligations and responsibilities. It provides motivation and team synergy, involves mentoring, directing operations with confidence, gaining trust and cooperation from the team. Inquiring, advocating, getting/ giving feedback and developing the team. Ensuring everyone in the team shows leadership.

Leadership Markers: the Captain sets tone for free exchange of ideas. He/She starts team-building with a good briefing and manages all aspects of flight. Captain directs crew activities in emergencies and ensures all tasks are completed where all team members are supplying information, ideas and feedback. The Captain must use the appropriate level of authority required for the situation. For a good crew, the authority is natural and low key.

Workload Management: The crew's WORKLOAD is a result of demands and threats that the crew must respond to. One of the first things any pilot learns regarding workload management is: AVIATE – NAVIGATE –COMMUNICATE. To this we must add.....MANAGE. Managing Workload involves prioritizing and delegating tasks. Possible overload conditions should be recognized and rectified. Company and other outside resources should be used. Make extensive use of SOPs. Overviewing and monitoring of work progress. Workload saturation should be recognized and communicated, then future workload anticipated and/or carried out in advance. Periods of low workload can be used to prepare for high workload thus not allowing things to become rushed. Make good use of automation to reduce workload. Communicate and receive acknowledgement of crew duties.
Preventing overload may entail spreading out the workload, allowing no casual conversation during high-workload periods. Treat any interruption of checklists as a serious hazard and work hard to maintain the big picture in an unusual situation by using all available resources and learning to say NO.

12.3.3 Situational Awareness:

It is important for good decision-making and all other CRM skills. Situational awareness is the accurate perception of the factors and conditions that affect an aircraft and its flight crew during a defined period of time. In simplest terms, it is knowing what is going on around you –a concept embraced to the need to "think ahead of the aircraft".

There are three types of situational awareness, namely:

- System awareness
- Environmental awareness
- Time awareness

Situational awareness has three levels:

Level 1: Failure to correctly perceive information - Data not available or hard to detect, Failure to monitor or observe data, Misperception or memory loss

Level 2: Failure to correctly comprehend information - Poor mental model, Use of incorrect mental model, Over-reliance on default values

Level 3: Failure to project the future situation – Lack of/or poor mental model and, over-projection of current trends.

Barriers to Good SA include; preoccupation with minor mechanical problems, inadequate leadership, failure to delegate tasks and assign responsibilities, failure to set priorities, inadequate monitoring, failure to utilize available data, failure to communicate intent and plans.

Dangers Areas (Red Flags) include; high-workload phases e.g. departure, arrival, emergencies. Low-workload phases e.g. funneling, minor emergencies, changed situation, unexpected/unplanned events.

After a deviation, it is important that the first actions be correct and timely to avoid the recovery from one upset leading to a new upset. Troubleshooting the cause of the upset is secondary and can wait. The situation analysis process includes:

i) determining the bank angle;
ii) determining the pitch attitude;
iii) confirming the attitude by reference to other indicators, as available; and
iv) assessing of the energy state

Complacency can be described as; overconfidence, repetitive tasks (e.g. before takeoff checklist), periods of low stress, boredom, monitoring for lengthy periods of time, sense of security when working with experienced colleague, automation, fatigue, etc.

To improve situational awareness ask: Where are we? Where are we going? How are things going? (Knowing the status of the aircraft, crew and passengers). Question status when it feels wrong and endeavor to understand the current conditions. Anticipate potential outcomes and continually review/monitor/predict. Communicate changes or expected changes.

12.3.4 Decision-Making (DM) Techniques – Outline

- DM Model
- DM Factors
- Risk Assessment
- Outcome Review

Simple Model of Decision Making is sequenced as; Detect change, Set Objectives, Develop Alternatives, Choose the best, then, do it. Afterwards evaluate the outcome.

Modes of Decision-Making include; conscious mode which is restricted in capacity, slow, sequential and error-prone. Automatic Mode which is unconscious, limitless, fast, operates in parallel (many things at once), and not generally a problem-solver.
Factors Leading to DM Error include; Information gathering whereby information may be wrong, or misinterpreted. Information processing which involves paying attention to one task while important changes may be missed because of failure to validate information by crosschecking. Decision-making which is influenced by physiological, psychological, organizational, cultural, communication and judgement factors.
Organizational issues affecting decision making include; conflicting goals (safety vs. bottom line), conflicting and/or inadequate policies or procedures, lack of/or inadequate resources (equipment, training, etc.), commercial pressures.
Judgment is a process of choosing which alternative will give the safest outcome in a situation. Factors affecting good judgment are; lack of vigilance, distraction, Peer pressure, insufficient knowledge, not aware of consequences, forgetful of consequences, ignoring consequences, overconfidence, etc.
Pilots should focus on stabilizing the aeroplane. They should know the appropriate pitch and power targets for stabilization and take the appropriate corrective action.

12.3.5 Physiological factors

Flight crew incapacitation and lack of proper use of Crew Resource Management can lead to Loss of Control-Inflight and Aircraft Upset situations.
Other causes over the years have continued to be analyzed. Research has shown that receptors found throughout the body, known as somatosensory receptors (commonly referred to giving feeling and G forces) located all over the skin, bones, joints, skeletal muscles, internal organs and the parts of the cardiovascular system, will also be providing information to the brain, as a pilot flies. This information can be in conflict with the visual and vestibular senses. These false or conflicting sensations can result in the pilot experiencing spatial disorientation even when in VMC.
The following should be addressed in the training:
i) conditions which can lead to spatial disorientation and the use of instrument interpretation to manage spatial disorientation;
ii) avoiding errors in adjusting attitude/power;
iii) avoiding, and recovering from, pilot-induced oscillations (PIOs); and
iv) recognizing and managing sensory illusions in flight.

12.3.6 Startle and stress response

Another significant contributor of aircraft upsets and LOC-I is the startle effect as in AF447, Rio De Janeiro to Paris. Startle effect in aviation has been defined as “an uncontrollable, automatic reflex that is elicited by exposure to a sudden, intense event that violates a crew member expectations.” This could lead to an intuitive but inappropriate response to the situation by the crew member. CRM skills such as effective coordination, monitoring and cross checking, situational awareness come in handy to forestall startle and in coping and managing a startling event once it has occurred.
Any situation or factor that interferes with the flow of flight information to the pilots increases the potential for disorientation. It is the pilot's responsibility in preventing airplane upsets due to startle effect or spatial disorientation to practice:

- Active monitoring

- Effective planning
- Disciplined adherence to SOPs
- Etc.

12.4 ADDITIONAL GUIDANCE ON AIR OPERATOR PROCEDURES

The following are examples of relevant extracts from Company Operations Manual Part A, SEP Manual & Flight Crew Technique Manual, highlighting sequential procedures as required:

12.4.1 Policy

a) Two verbal communication rule - When a fight crew member does not respond normally or appropriately to two verbal communications, incapacitation should be suspected. Also if a crew member does not respond to any verbal communication associated with a significant deviation from the intended flight path.

b) Flight crew member incapacitation - If a cockpit crew member becomes incapacitated, the remaining flight crew member will ensure a safe flight condition by the following priority:

- Fly the airplane by taking control of the aircraft: use max automation,
- Check position of all essential controls and switches,
- Navigate the airplane by ensuring that the aircraft is in the determined flight path,
- Communicate and declare an emergency explaining the situation;
- Call the Lead Cabin crew to assist with the incapacitated crew member;
- Inform Central Operations Control.

Once the safety of the aircraft is certain, the remaining flight crew will:

- Ascertain the facts e.g. a crew member is incapacitated,
- Evaluate the options e.g. can flight continue to destination /divert to departure /enroute alternate,
- Analyze the risk e.g. analyze the risks involved with each of the three options,
- Make and execute decision.

As soon as practicable call the lead cabin crew to the cockpit for assistance and explain the nature of problem, communicate intentions about further flight, give estimates - time to land, inform if evacuation is required /not required.

c) Cabin crew shall remain in the cockpit to take care of the incapacitated crew.
The lead cabin crew must do the following:

- Tighten & manually lock the shoulder harness of incapacitated crew,
- Pull the seat completely aft,
- Recline the seat back rest.

d) Incapacitated cockpit crew member should be removed from the cockpit before administrating any medical assistance. In coordination with the lead cabin crew, check if a type qualified company pilot is on board to replace the incapacitated crew member.

e) Get incapacitated crew member offloaded to the ambulance as quickly as possible. This could be at the gate /bay.

In-flight incapacitation cases shall be fully evaluated at Special Medical Examination Centers as specified. During medical assessment, areas of increased medical risk shall be identified and the cases shall be followed up with continuous re-evaluation of the medical assessment to concentrate on the identified areas of increased medical risk and records maintained.

12.4.2 Safety & Emergency Procedures

The Lead (Senior Cabin Crew) nearest cabin crew to enter the cockpit with a note pad and pen (press # to enter or use emergency code, if required). Ensure affected pilot's seatbelt is fastened. Secure hands into the shoulder harness and lock it. Move pilot's feet away from the rudder pedals. Move the seat completely aft using the electrical switches or manual levers. Recline the seat back completely. Loosen tight clothing, follow first aid procedures and administer oxygen from the QDM on emergency mode (if required).

The Lead (Senior Cabin Crew) should read the cockpit checklist if required whilst sitting on the observer seat. After reading out the checklist, the Lead (Senior Cabin Crew) must occupy her jump seat for landing. It is recommended that the cabin crew must be fully trained and confident in handling a case of seizure. The following points need to be kept in mind:

- Must check & record pulse, temperature, Blood Pressure and respiratory rate of the involved flight crew;
- In case the individual is having seizure, after convulsion ceases, turn individual to a semi prone position, ensure that airway is clear;
- To prevent tongue biting, a padded gag or tightly rolled handkerchief may be inserted between the teeth.
- In case the QDM is used for administrating oxygen to the incapacitated flight crew, the cabin crew must ensure that the Airway (mouth, nose & throat) is patent.

12.4.3 Evaluation of Inflight Incapacitation of Flight Crew – Research

A scientific research was conducted by Nikolai I. Plotnikov of Civil Aviation Institute, and Aviation Manager Novosibirsk, in Russian (Federationam@aviam.org). In this research, analysis on the subject of loss of capacitation of the flight crew was performed. They assumed complete loss of capacitation (Incapacitation) and temporary or partial loss of capacitation (Impairment). The loss of performance of the pilot (Pilot Incapacitation - PI) and especially all the crew members (All Pilot Incapacitation - API) is a critical and extremely dangerous event. The development of the API inflight subject covered technical and organizational considerations. Technical measures to prevent aviation accidents (AA) from dangerous API events may include:

a) further enhancement of the automation of modern aircraft and their ability to complete a flight automatically, without human intervention;

b) Development of technical means of controlling the aircraft from the ground and flying it with remote flight control.

c) Training in automated approach and landing of cabin crew; providing preferential or free flights to technical persons involved in aviation.

A method of emergency delegation (ED) in case of loss of flight crew capacitation was developed. The purpose of the study was to assess the risks of successful completion of the flight when delegating control of the aircraft to a third party in the event of loss of crew capacitation. Event simulations were performed in training experiments. As a result of the experiments, conclusions were made about the possibility of safely completing flights with the support of an experienced pilot from the ground to flying of the aircraft by a third-party, a passenger or flight attendant.

It was ascertained that, in the case of partial loss, the pilot can perform some functions, such as reading the checklist, maintaining communication. In case of complete loss of capacitation, the individual is not able to perform any duties. The lack of adequate response to standard communication with air traffic control (ATC) and operating procedures (SOPs) of crew members is a sign of loss of capacitation. If the crew lose their ability to work, the imperative of survival sets the task of emergency delegation (ED) of control of the aircraft. The ED cases and forced control of an aircraft by a third party are rare, but real events.

The largest share of common causes of PI are loss of consciousness and heart attacks. Full PI occurs in cases of hypoxia, cardiovascular disease, loss of consciousness, diabetes, reactions to medications, and injuries. Partial PI occur in respiratory and gastro-intestinal diseases, food poisoning, acute fatigue, kidney attacks, and vision deficiencies. Partial PI events can be concealed by pilots due to the threat of being decommissioned.

Determining the causes of AA by PI is a difficult task, because these facts are hidden in a chain of other causes. Determining PI can be performed from aviation medical research, simulator experiments, survey data, and the study of data at the end of a pilot's flight career.

CHAPTER 13: UPRT FOR RPAS

13.1 SARPs

Annex 1

B. LICENCES AND RATINGS FOR REMOTE PILOTS
Applicable as of 3 November 2022

2.11.5 Requirements for the issue of class and type ratings

-for the issue of an aeroplane category type rating, upset prevention and recovery training

2.13.3.2 Remote pilot licence training

2.13.3.2.3 The applicant shall have received dual remote pilot licence training in an RPA and associated RPS, sought from an authorized RPAS instructor. The RPAS instructor shall ensure that the applicant has operational experience in all phases of flight and the entire operating envelope of an RPAS, including abnormal and emergency conditions, upset prevention and recovery training for the categories concerned, as well as IFR operations.