
Subject: All-Attitude Upset Recovery Strategy (AAURS)

Background

Over the past ten years, Loss of Control In-Flight (LOC-I) has replaced Controlled Flight into Terrain (CFIT) as the number one cause of fatalities related to aircraft accidents. From 2004 to 2013 there were 1,576 fatalities worldwide attributed to LOC-I on commercial jet aircraft. This was almost double the number two cause of fatalities, CFIT, which resulted in 804 fatalities worldwide.

In response to these fatal accidents, a large working group was formed that consisted of the FAA, NTSB, ALPA, airlines, IATA, and several other industry professionals to determine why LOC-I is the leading cause of fatalities in aviation. The group examined current training and procedures to see if this was a contributing cause. As a result of the findings, the FAA issued two advisory circulars: AC 120-111 Upset Prevention and Recovery Training, and AC-109A Stall Prevention and Recovery Training. These Advisory Circulars provide background information and details on how airlines should train instructors and pilots on these procedures.

All airlines are required to establish a training program for their instructors and pilots that address the issues in these Advisory Circulars by 2019.

The purpose of this FB is to provide information that Delta pilots will see in upcoming QCQ and CQ training, and to ensure Delta's program aligns with the industry direction and the ACs mentioned above. Future FCTM revisions will incorporate the appropriate elements of this information.

All-Attitude Upset Recovery Strategy (AAURS)

Delta's goal in upset prevention is that pilots constantly anticipate and mitigate situations that can lead to an upset. While this will help to reduce the number of upset encounters, it cannot completely eliminate them. This All Attitude Upset Recovery Strategy is designed to be an easily recallable tool when crews are faced with time-critical, life threatening aircraft upsets. This strategy also helps overcome the startle factor of an upset and can be used to recover from aircraft upsets or stalled conditions. Before implementing this strategy, first ensure the upset has been recognized and confirmed.

RECOGNIZE and **CONFIRM** if the aircraft is in an undesirable state and outside of normal parameters. Prompt recognition by the PF, and active monitoring by the PM, will help recognize conditions leading toward an upset. The undesirable flight path is confirmed by cross checking primary and secondary flight instruments, and if available, use outside references.

VERBALIZE "Upset, Recover" announced by either pilot. During the recovery each step of the recovery strategy will be verbalized by the PF. This enhances crew awareness and ensures each step is accomplished.

RECOVER using the AAURS. The PF will take prompt action to execute the strategy to recover the aircraft to stabilized flight without exceeding aircraft limitations. The PM will verify all required actions have been accomplished and communicate any omissions. The PM will also monitor altitude and airspeed, and call out any trend toward terrain.

If an upset situation is recognized and confirmed, immediately disconnect the autopilot and autothrottle systems and accomplish the All-Attitude Upset Recovery Strategy:

PUSH
ROLL
POWER
STABILIZE

PUSH - The push step is the first and most important action of the strategy which reminds the PF to manage aircraft angle of attack during the upset or stall. The PF will reduce the angle of attack by applying nose down elevator with neutral ailerons. In some cases simply relaxing the back pressure is appropriate; however in some situations and trimmed conditions a more aggressive forward movement is required. In either case, unload the aircraft to feel a slight lightness in the seat, which approximates +0.5 G. Avoid pushing excessively to prevent negative Gs. Reducing angle of attack allows for a stalled wing to regain lift and prevents asymmetric G loading.

ROLL - Only after unloading to +0.5G, roll to manage the lift vector using ailerons while maintaining +0.5 G. Maintaining +0.5 G during the roll will allow maximum roll rate while reorienting the lift vector to the nearest horizon. Use smooth deliberate aileron input proportional to the upset condition. In some instances, full aileron deflection may be necessary. Avoid the tendency to roll and pull. This reduces the roll rate, can overstress the aircraft, and possibly lead to an accelerated stall. The use of rudder is normally not needed. The yaw damper provides sufficient rudder stability. If aileron control is ineffective, careful use of rudder to aid roll control and suppress yaw should be considered. Rudder that is applied quickly or held too long may result in loss of lateral and directional control, and cause structural damage. In an extreme nose up or down condition, the horizon will always be visible at the top or bottom of the PFD to aid in determining the nearest horizon.

WARNING: Rudder reversals (rapid full rudder deflection from side to side) should be avoided and can quickly lead to overstressing the aircraft.

POWER - Assess aircraft's energy state. Add or reduce power as required. Power is primarily used to manage energy in the form of speed and altitude, and secondarily influences pitch. Speedbrakes may also be required in a nose-low, rapidly increasing airspeed situation.

STABILIZE - The stabilize step is an action that continues to maintain aircraft control by setting an appropriate pitch and power setting until stable flight is obtained. Once obtained, the PF should assess aircraft configuration, and adjust the speedbrakes, trim, and configuration as necessary. Altitude loss should not be the primary consideration during any upset or stall recovery. To avoid overstressing the aircraft stay within transport category G limits. Avoid excessive loads while establishing a proper pitch setting. During nose-high recoveries, it may be necessary to lower the nose below the horizon in order to obtain a safe airspeed. Both pilots should ensure the recovery is complete and the aircraft stabilized before addressing why the upset occurred.

Upset Parameters

An upset can generally be defined as unintentionally exceeding the following conditions:

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

Flight Upset Recovery

Pilot Flying	Pilot Monitoring
Recognize and confirm	
Announce “UPSET, RECOVER”	
Disconnect autopilot and autothrottle. Note: Do not use flight director commands during the recovery. Accomplish and verbalize the All-Attitude Upset Recovery Strategy. “Push” - Reduce angle of attack by applying nose down elevator with neutral ailerons. If stalled, continue to apply nose down elevator control inputs until stall recovery is complete and stick shaker activation ceases. “Roll” - Only after unloading, roll to manage the lift vector using ailerons while maintaining +0.5 G. “Power” - Assess energy state. Add or reduce power as required. If ground contact is imminent, select emergency thrust by advancing the throttles beyond the max forward throttle gate detent. Note: Up to maximum thrust may be required. Note: Speedbrakes may be required in nose-low, rapidly increasing airspeed condition to control excessive speed. Note: For tail mounted engines, adding power will cause a pitch down moment during extreme nose-high conditions. “Stabilize” - Adjust pitch and power to achieve stable flight. After a stabilized flight condition is met above Vmin, adjust speedbrakes, trim, and configuration as appropriate.	Monitor altitude and airspeed. Verify all required actions have been accomplished and call out any omissions. Call out any trend (i.e., airspeed, altitude, and any trend toward terrain contact).

Post All-Attitude Upset Recovery Strategy (AAURS) Considerations

- Consider declaration of emergency
- Landing lights on
- Coordinate new clearance with ATC
- Assess condition of cabin crew and passengers
- Consider structural integrity of aircraft
- Consider diversion and coordinate with dispatch
- Make PA
- Complete Normal and Non-Normal Checklists as appropriate
- For guidance on aircraft accidents/incidents, refer to FOM, chapter 10.3, Accidents, Incidents, or Irregularities.

Conclusion

Avoidance of situations that may lead to an aircraft upset, is priority. However, in the event an upset or stalled flight condition is encountered, execute the All-Attitude Upset Recovery Strategy (AAURS).

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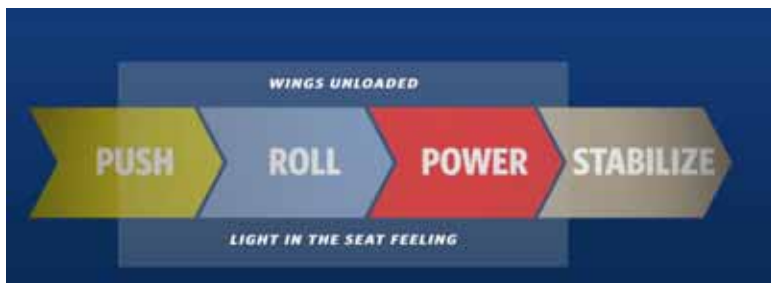
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Technical Manager

Upset Recovery Addendum

Note: The information below will be incorporated in the next FCTM revision.

The All Attitude Upset Recovery Strategy is a detailed and organized plan of action designed to assist pilots in the recognition and recovery from loss of control in flight. It is critical that each step is correctly applied and executed before moving on to the next step in the strategy. The PUSH, ROLL and POWER step should all be executed while the aircraft is in an UNLOADED STATE (a slight light in the seat feeling). The figure below is a pictorial representation of the PUSH, ROLL and POWER step being in an unloaded state.



Upset Recovery

Nose-High (AAURS) Additional Considerations

A nose-high upset may be a situation where the aircraft pitch attitude unintentionally exceeds and/or increases more than 25° nose-high, associated with rapidly decreasing airspeed. As airspeed decreases, the pilot's ability to maneuver the aircraft also decreases. If the aircraft is trimmed nose up, as for slow-speed flight, it partially reduces the nose-down authority of the elevator. At full thrust settings and very low airspeeds, the elevator, working in opposition to the stabilizer, has limited control to reduce the pitch attitude. In this situation the pilot should trade altitude for airspeed, and maneuver the aircraft's flight path back toward the horizon. This is accomplished by applying up to full nose-down elevator and the use of some nose-down stabilizer trim.

These actions should provide sufficient elevator control to produce a nose-down pitch rate. It may be difficult to know how much stabilizer trim to use, and care must be taken to avoid using too much trim. Pilots should not fly the aircraft using stabilizer trim, and should stop trimming nose down when they feel the G force on the aircraft lessen or the required elevator force lessen. This use of stabilizer trim may correct an out-of-trim aircraft and solve a less critical problem before the pilot must apply further recovery measures.

Note: In some cases, it may be necessary to reduce power to ensure that the elevator authority is sufficient to reduce the angle of attack.

If elevator control inputs are ineffective, adjust the bank angle to achieve the desired rate of pitch reduction while considering energy management. Bank angle adjustments, not to exceed 60°, may achieve a nose-down pitch rate. With airspeed as low as stick shaker onset, normal roll control, up to full deflection of ailerons and spoilers, may be used. The rolling maneuver reduces the vertical component of lift, allowing the nose to pitch down. If normal pitch control and aileron roll control are ineffective, careful rudder input in the direction of the desired roll may be required to induce a rolling maneuver for recovery. Pilots should exercise caution if applying rudder. The reduced pitch attitude allows airspeed to increase, thereby improving elevator and aileron control effectiveness. After the pitch attitude and airspeed return to a desired range, the pilot can reduce angle of bank with normal lateral flight controls and return the aircraft to normal flight.

WARNING: Rudder reversals (rapid full rudder deflection from side-to-side) should be avoided and can quickly lead to overstressing the aircraft.

Nose-Low (AAURS) Additional Considerations

A nose-low upset condition may be a situation where the aircraft pitch attitude is unintentionally more than 10° nose low and airspeed is increasing rapidly. The nose-low upset requires prompt action by the pilot since altitude is rapidly being exchanged for airspeed. Even if the aircraft is at a high enough altitude that ground impact is not an immediate concern, airspeed can rapidly increase beyond aircraft design limits.

For all attitudes, including inverted flight, the first step of pushing forward to attain .5G is critical. Pilots must overcome the first reaction to pull when the angle of bank exceeds 90°. Full aileron and spoiler input should be used if necessary to smoothly establish a recovery roll rate toward the nearest horizon. If the use of full lateral control (ailerons and spoilers) is not satisfactory, it may be necessary to apply rudder in the direction of the desired roll. Rudder that is applied too quickly or held too long may result in loss of lateral and directional control, and cause structural damage.

WARNING: Rudder reversals (rapid full rudder deflection from side-to-side) should be avoided and can quickly lead to overstressing the aircraft.

It is important not to increase G load or use nose-up elevator or stabilizer until approaching wings level.

Application of roll followed by a reduction of thrust, to include deploying speedbrakes, may be necessary. Speedbrake extension causes a nose-up pitching moment, an increase in drag, and a decrease in lift for the same angle of attack. At airspeeds well above VMO/MMO the ability to command a nose-up pitch rate with elevator may be reduced because of the extreme aerodynamic loads on the elevator. Maneuver the aircraft's flight path back toward the horizon. At extremely low pitch attitudes and high airspeeds (well above VMO/MMO), nose-up elevator and nose-up trim may be required to establish a nose-up pitch rate.

High Bank Angle Considerations

A high bank angle is one beyond that necessary for normal flight. The bank angle for an upset has been defined as unintentionally more than 45°, however, it is possible to experience bank angles greater than 90°. Any time the aircraft is not in "zero-angle-of-bank" flight, lift created by the wings is not being fully applied against gravity, and more than 1 G is required for level flight. At bank angles greater than 66°, level flight cannot be maintained within AFM load factor limits.

During nose-high upsets, the pilot must apply nose-down elevator to unload the aircraft and possibly adjust the bank angle to achieve the desired nose-down pitch movement while considering energy management. Once the pitch attitude has been reduced sufficiently to ensure airspeed is regained, reduce the bank angle, and return the aircraft to normal flight.

During nose-low upsets, a high angle of bank requires prompt action by the pilot as altitude is rapidly being exchanged for airspeed. Even if the aircraft is at a high enough altitude that ground impact is not an immediate concern, airspeed can rapidly increase beyond aircraft design limits. It may be necessary to apply nose-down elevator to limit the amount of lift, which will be acting toward the ground if the bank angle exceeds 90°. This also reduces wing angle of attack to improve roll capability. Full aileron and spoiler input should be used if necessary to smoothly establish a recovery roll rate toward the nearest horizon. It is important to not increase G load or use nose-up elevator or stabilizer until approaching wings level.

Stall or Approach to Stall Characteristics

An approach to a stall is a controlled flight maneuver. A stall is an out-of-control, but recoverable, condition. However, the recovery maneuver is the same for either an approach to stall or a fully developed stall.

Most approach to stall incidents have occurred where there was altitude available for recovery. The incidents that progressed into accidents often occurred because the crew failed to make a positive recovery when the stall warning occurred, the condition progressed to a full stall, and the aircraft impacted the ground in a stalled condition. For this reason, emphasis has shifted from a recovery with minimum loss of altitude to reducing the angle of attack below the wing's critical angle of attack to complete a positive and efficient recovery.

During initial stages of stall, local airflow separation results in buffeting (initial buffet), giving natural warning of an approach to stall. A stall warning is considered to be any warning readily identifiable by the pilot, either by artificial stall warning (stick shaker) or initial buffet.

Recovery from an approach to stall is initiated at the earliest recognizable stall warning, initial buffet, or stick shaker. Aircraft specifications require a warning for an impending stall.

An aircraft may be stalled in any attitude (nose-high, nose-low, high or low angle of bank) or any airspeed (as in an accelerated stall). It is not always intuitively obvious that the aircraft is stalled. In common with most other T-tail aircraft, the aircraft is subject to a characteristic known as the "deep stall". This term refers to an angle-of-attack range beyond the normal stall region in which the tail enters the turbulent wakes of the wing and nacelles. This causes a loss in tail effectiveness and a tendency to pitch up until the aircraft stabilizes at some very high angle-of-attack. Entry into the deep stall may not be readily apparent to the pilot since an increase in angle of attack may be accompanied by increasing sink rate and flight path angle so that pitch attitudes remain low.

An aircraft stall is characterized by one or more of the following conditions:

- Stall warning
- Buffeting, which could be heavy
- Lack of pitch authority
- Lack of roll control
- Inability to arrest descent rate.

Stall or Approach to Stall, Additional Considerations using the AAURS

To initiate the recovery, reduce the angle of attack by applying up to full nose-down elevator. The use of nose-down stabilizer trim may be required to reduce the critical angle of attack. These actions should provide sufficient elevator control to produce a nose-down pitch rate. It may be difficult to know how much stabilizer trim to use, and care must be taken to avoid using too much trim. Pilots should not fly the aircraft using stabilizer trim, and should stop trimming nose down when they feel the G force on the aircraft lessen or the required elevator force lessen. This use of stabilizer trim may correct an out-of-trim aircraft and solve a less-critical problem before the pilot must apply further recovery measures. The use of too much trim may result in the loss of control or high structural loads.

Ailerons and roll spoilers are ineffective in a stalled condition. Any attempt to level the wings while stall indications are still active could aggravate the condition. The reduction of angle of attack (unload) must be held until all indications of the stall are eliminated. After the stall is broken, normal roll controls, up to full deflection of ailerons and spoilers, may be used to roll in the shortest direction to wings level. Rudder should not be used since the yaw damper provides sufficient rudder stability.

Aircraft configuration changes should be considered only after stall /upset, indications/conditions no longer exist. Aircraft manufacturer recommendations and limitations should be observed before making any configuration changes. Changing the aircraft's configuration during the recovery may cause the following:

- Result in an increased altitude loss
- Exceed the aircraft's limitations
- Cause structural damage.

Note: If conditions permit, accept an altitude loss while accelerating to an appropriate speed for existing configuration.

Note: Premature recovery may result in a secondary stall or inability to accelerate with available thrust.

Note: Use care during recovery from a nose-low attitude after the stall indications have stopped. If the pull up is too aggressive, a secondary or accelerated stall would require an additional application of the All-Attitude Upset Recovery Strategy (AAURS).

High Altitude Recovery

At higher altitudes, normally above 20,000 feet, the aircraft becomes increasingly thrust limited. If an approach to stall indication is experienced, nose-down elevator is required to reduce AOA and initiate a descent. Stabilizer trim may also be required

Since engine performance at high altitude is reduced, altitude needs to be traded for airspeed. Therefore, a recovery at high altitude results in a greater altitude loss than a recovery at low altitudes. Accelerate to cruise or climb Mach before attempting to stop altitude loss.