Upset Recovery Training Aid, Revision 2

By: Larry ROCKLIFF
V.P., Training and Flt. Ops Support, Customer Services, Airbus Americas

1 | Introduction

The original industry upset recovery training was delivered to the aviation community ten years ago. The genesis of this reference was a discovery that many pilots had progressed along their career and had never been educated in recognition and recover from upsets or unusual attitudes. Ten years later, the accident/incident rate due to failure to recover from an upset, remains among the top statistics to work on. There are various reasons for this, not the least of which is a regulatory base that allows to add training modules to an operator's program, but is less agreeable to remove modules that have much less significance in the operating environment of today.

In recent years, there have been several accidents and incidents that have occurred in the high altitude environment. Odd as it may seem, causal factors from several investigations have been a lack of understanding of phenomena associated with operating a jet aircraft in the high altitude environment. To respond to this shortfall in a pilot education, the FAA asked Airbus and Boeing to convene an industry group to define a training aid specific to high altitude operations. The result has been a collaborative effort that consisted of manufacturer, airline, safety, regulatory, industry trade, and educational organizational representatives both domestic, within the United States, and international in scope to arrive at a document that addresses the problem.

Consensus from the group was to amplify information and guidance vis a vis high altitude already embedded in the existing Industry Upset Recovery Training Aid and deliver it as Revision 2. This is now available to operators on *https://w3.airbusworld.com*.

In addition, because the FAA requested a specific reference for high altitude to respond to NTSB recommendations, it was decided to also provide a separate stand alone supplement to specifically address high altitude phenomena. This is a separate appendix, which is contained in the back of the Training Aid.

2 | Goal

The goal of Revision 2 is to focus on specific education for pilots so they have the knowledge and skill to adequately operate their airplanes and prevent upsets in a high altitude environment. This includes educating pilots so they can develop the ability to recognize and prevent an impending high altitude problem and increase the likelihood of a successful recovery from a high altitude upset situation should it occur.

As surprised as regulators and industry was to discover in the 1990s that many pilots did not have the knowledge and skills to recognize and recover from any upset or unusual attitude, it came equally as baffling to learn that pilots had exceedingly limited knowledge and abilities to handle their airplanes in the high altitude environment in spite of the fact they operate in this area over 98% of their flight time experience. Indeed, many pilots have never had the opportunity (or requirement) to operate their aircraft in the high altitude environment with an Auto Pilot off to experience the differences.

3 | Take Away

There is considerable content within the Training Aid Revision 2 and Airbus recommends that operators refresh their knowledge and skills with a view to introduce primary and/or refresher training for their crews. With all the information available to the training departments, the take away to each and every pilot has been distilled into three simple guidelines:

- Contain The Startle Factor
- Recognize and Confirm the Situation
- Very Small Control Inputs

Containing the startle factor applies to every situation a pilot may encounter, regardless of high altitude or sea level operating environment. It is a natural reaction; perhaps even reflex action, to want to do something when one is startled. Reactively, disconnecting an Auto Pilot and making un-calibrated open loop rudder and/or control yoke or sidestick inputs will never be the correct reaction and will almost always lead to an amplified abnormal situation. It is in this area that pilots must develop skills to discipline themselves from putting their hands and/or feet into motion, without first understanding what is going on and what the potential consequences of their actions will be. Disconnecting the Auto Pilot under effort in a reflex action is particularly significant as it generally results in a large control input. Indeed, many high altitude upsets would never have become upsets had pilots contained the startle factor. This is a critical area of human factor development that cannot be overstated.

Recognize and confirm the situation is essential for the pilot to determine what recovery action is necessary. Some situations develop quite slowly in which case, the crew will have ample time to assess and decide upon a course of action. However, some may occur nearly instantly, and in these cases the pilot/crew must determine what is happening to their energy state and what is happening to their trajectory. It may not be easy, but it is critical in order for the crew to decide what response they will need to take. In the same way that many engines have been un-necessarily shutdown before sufficient information had been considered, so too, have high altitude upsets been created, due to reacting to only part of the available information. This is a broad area that cannot be distilled into the scope of this article, but sufficient to say that a corrective action cannot be contemplated without consideration of what the pilot/crew is responding to. The link between containing the startle factor, recognizing and confirming the situation, can be fused together to allow the pilot to apply the third and always essential take away point.

Very small control inputs cannot be overstated. Open loop, or arbitrary large scale deflections must be avoided at any altitude. The relationship between control surface deflection and trajectory change is amplified at high altitude.

- The airspeed at high altitude is generally higher than the one pilots are used to fly at manually. Therefore, a reflex action giving the same control surface deflection will result in a much higher load factor than initially expected.
- For the same control surface movement at constant airspeed, an airplane at 35,000 ft experiences a higher pitch change than an airplane at 5,000 ft because there is less aerodynamic damping. Therefore, the change in angle of attack is greater, creating more lift and a higher load factor.
- Moreover, if the input is large enough, pitch up may happen, amplifying the formerly described effect and buffeting may occur, creating a second startle factor that may trigger another large reaction in the opposite direction.

If the control system is designed to provide a fixed ratio of control force to elevator deflection, it will take less force to generate the same load factor as altitude increases.
On many modern airplanes with classical, non reversible flight controls, the control force to elevator ratio is varying with airspeed so as to give roughly a constant force for the same load factor all over the flight envelope. This is even more true for fly-by-wire airplanes flying with C* pitch control law where sidestick deflection is actually a load factor demand.

A similar discussion could be held for the yaw axis with rudder inputs.

Nevertheless, and whatever the flight control system, an additional effect is that, for a given attitude change, the change in rate of climb is proportional to the true airspeed. Thus, for an attitude change for 500 ft per minute (fpm) at 290 knots indicated air speed (KIAS) at sea level, the same change in attitude at 290 KIAS (490 knots true air speed) at 35,000 ft would be almost 900 fpm. This characteristic is essentially true for small attitude changes, such as the kind used to hold altitude. It is also why smooth and small control inputs are required at high altitude, particularly when disconnecting the Auto Pilot (an Auto Pilot disconnection by overriding it on the yoke or sidestick controller will very likely cause large and excessive control inputs). Put in fundamental piloting terms, inappropriate control inputs due to uncontained startle factor without consideration for what is actually occurring, can almost certainly cause an upset to become exaggerated, or indeed precipitate one that didn't exist in the first place. Simply stated, all control inputs must be in the form of control pressures versus control deflections. Incidentally, this is identical to the relationship in the larger movements on an automobile steering wheel when nearly stopped as opposed to the tiny pressures warranted while at high speeds. Imagine the result of a large steering wheel deflection at highway speeds…

4 Airbus Policy toward Upset Recovery Training

Airbus policy has been consistent since the original Industry Upset Recovery Training Aid was offered in 1998. Airbus believes it is practical and encouraged to educate all pilots to understand the principles of airplane upsets and how to avoid them. The dynamics of airplane upsets at low altitude or high altitude are so broad that defining simplistic procedures or techniques are not appropriate. To that end, upset recovery training is encouraged in the context of awareness training versus procedure training.

Moreover, Airbus does not support the use of full flight simulators to conduct upset recovery training. Although excellent training tools within the normal operating environment and envelope the pilot/crew experiences in his/her duties, simulators have many limitations that create enormous opportunities for negative training. Airbus believes the risk of producing significant negative training far outweighs the possible benefit that might be achieved.

High altitude exercises as proposed in the most recent Revision 2 of the Industry aid, is consistent with Airbus training policy. Because the scenarios recommended are focused towards recognizing a developing situation so the pilot/crew can arrive at a solution prior to entering an upset, the use of simulators in these scenarios are appropriate.

Some operators may still decide to use simulators to conduct upset recovery training. In these cases, Airbus recommends to only use the simulators with the motion systems selected off. This is not to protect the serviceability of the equipment due to large motion movements toward the stops. Rather, it is an attempt to minimize the likelihood of negative training due to incorrect motion cues and lack of accelerations. Indeed, positive re-enforcement derived from negative training, is the most difficult situation to manage. A pilot/crew should walk away from a training event with positive re-enforcement. However, if similar conditions taught in a simulator are experienced in an airplane, there could be large differences in how the airplane responds to the pilot inputs and consequences can be severe and unrecoverable. Finally, Airbus does not support intentionally suppressing normal law in order to facilitate upset conditions.

5 | Summary

Airbus has been a supporter of educating pilots to recognize and avoid airplane upsets. Though this knowledge and associated skills should have been acquired during earlier pilot training and not airplane type rating training, it is important to recognize that a knowledge gap exists within the pilot community and Airbus has been a leader in working with industry to arrive at a solution.

Contain the startle factor, recognize and confirm the situation and correct making the smallest control inputs/pressures possible to arrest any divergence in order to recover. These three points are powerful, positive “take aways”…

Safety First

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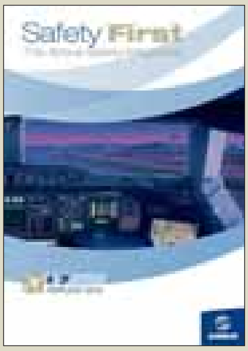
Airbus
Product Safety department (GS)
1, rond point Maurice Bellonte
31707 Blagnac Cedex - France
Fax: +33(0)5 61 93 44 29
safetycommunication@airbus.com



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