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THE PROBLEM OF UPSET RECOVERY TRAINING IN SCOPE OF AIR FRANCE AF447 ACCIDENT

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Introduction

Several recent fatal accidents of airliners show deficiencies in pilot manual flying skills under high angle of attack or stall conditions. The most recent and most severe of these accidents are Colgan Air in Buffalo and Air France near Brazilian coast. These two accidents showed inability of pilots to recover from a stall, although there was enough altitude available, in case of the Air France even for several recoveries. In this paper we will analyze deficiencies in upset recovery training in conjunction with the latter aircraft accident.

’On Sunday 31 May 2009, the Airbus A330-203 registered F-GZCP operated by Air France was programmed to perform scheduled flight AF 447 between Rio de Janeiro Galeão and Paris Charles de Gaulle. Twelve crew members (3 flight crew, 9 cabin crew) and 216 passengers were on board. The departure was planned for 22 h 00. Takeoff took place at 22 h 29.´ [1] 1st June 2009 at 2 h 14 min 28s the aircraft ended in waters of the Atlantic ocean. The airplane encountered flight through upper portion of a cumulonimbus cluster. ’When a water cloud is cooled to temperatures below 0°C there is a chance that ice crystals will begin to appear.´ [2] This happened also during this particular flight, and after brief pitot tube obstruction by ice crystals and subsequent airspeed indication unreliability, the pilot flying failed to continue in steady flight in the assigned flight level and induced a deep stall, which was not recovered until the water impact. The airspeed on all airspeed indicators was eronneous for 29 seconds. After this time the left airspeed indicator speed became valid,

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followed by the other indicators later. Although there were two copilots in the cockpit, with the aircraft captain coming after the triggering event of the accident, the stall condition was never recognized or announced by the crew. Full power and full up elevator deflection was selected almost the entire duration of the stall. All the other flight instruments except airspeed indicators were working as intended throughout the entire flight.

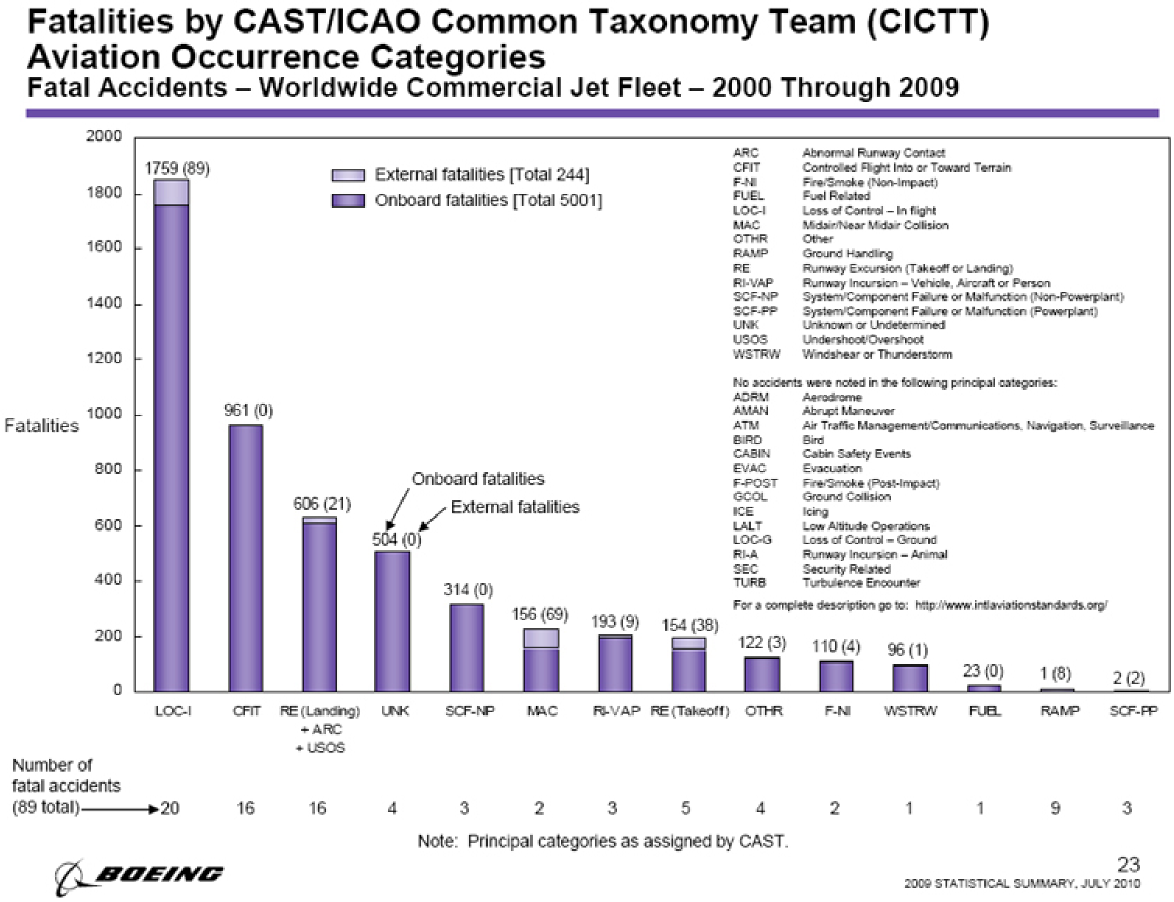
The crew failed to recognize the stall even though they were all experienced pilots with several thousend flight hours. one of the causes was recognised inefficiency of flight training, especially recurrent training, as the pilots did not have the basic manual flight habbits which are not used in everyday airliner flying. However, these habbits are well taught in the basic phases of pilot training like private pilot licence (PPL) and commertial pilot licence (CPL) training or integrated courses.

Upset recovery importance

A stall usually follows after insufficient speed and there are usually big roll variations throughout a deep stall. Both of these conditions are known as upset.

- An upset attitude is one of these states:
- Aircraft pitch attitude greater than 25º nose up.
- Aircraft pitch attitude greater than 10º nose down.
- Aircraft bank angle greater than 45º
- Flight within the above parameters, but at airspeeds inappropriate for conditions.

Aircraft upset attitudes often lead into a loss of control in flight and subsequently an accident related to this state. As an evidence of this factor importance on total number of fatal accidents through the last decade, you can see **Fatalities by main cause (2000 to 2009)**.



Fatalities by main cause (2000 to 2009) [3]

Regulatory and other reactions to accident

The FAA regulatory reaction for the Colgan Air accident was increasing the second in command minimum flight hours requirement to 1500 hours, an equivalent to airline transport pilot licence (ATPL). This reaction doesn't provide solution for the primary problem of manual flight skills deficiency, and what is more, it doesn't correspond to the actual crew experience in the time of the accident, as the co-pilot had almost 1500 flight hours logged.

EASA's reaction on the Air France accident is yet uncertain. The first outcome not relating to flight crew training is proposed by EASA as an Airworthiness Directive for an Airbus A330/A340 Flight Control Primary Computer (FCPC) software update.[4] EASA also issued an Airworthiness Directive (AD 2010-0271) issued in December 2010 and asked crews that found themselves in such a situation to make sure not to re-connect the autopilot before the airspeeds return to values consistent with flight for 30 seconds, due to a risk of pitch runaway that could constitute an "unsafe condition". [1] EASA also issued several other directives dealing with pitot probes icing. However, no effort was yet made to increase quality of training by inclusion of larger amount of upset recovery training into simulator sessions.

Air France reaction was following:

- The exhange of pitot probes of other manufacturer and design was accelerated after recurring problems with pitot probe icing.
- A new decision making method is being deployed, reinforcing the co-pilot's responsibilities.
- Changeover to manufacturer's documentation in English.
- Modification of rules for relieving the Captain in March 2010. [1]

What is most important, there was a new unreliable airspeed session included in pilot training. This session includes:

- 'Summer 2009 (A320, A330/A340). Session booklet and briefing: technical reminders, human factors and Threat and Error Management (TEM) aspects.
- Revision of the emergency manoeuvre, on take-off and in cruise phase.
- High altitude flight in alternate law.
- Approach to stall with triggering of STALL warning.
- Landing without airspeed indications.
- Related briefings (all flight crew): Weather radar and Ice crystals.
- Alternate Training & Qualification Programme (ATQP) (preliminary version) operational on Airbus A320 since March 2012.´ [1]

Airbus subsequently reviewed the "Unreliable speed indication" procedure proposing a session on the simulator at high altitude in normal and alternate law including manual aeroplane handling and carrying out the *unreliable speed indication* procedure. [1]

Current status of upset recovery training and possible future

Currently the main stress during flight training aims at upset and especially stalls prevention. Pilots are taught how to avoid situations leading to stalls, but experience from last decades accidents shows that inattention, disorientation, lack of situational awareness, improper flight control reactions and other numerous factors often lead to a stall situation which needs to be dealt with. As pilots do not have stall recovery training on the type of aircraft being flown, it might lead to incorrect reactions or even unrecognized stall condition, in the worst case followed by a fatal accident. Stall recovery is a compulsory item during basic flight crew training. However, it is conducted on small single engine aircraft and later marginally on small multi-engine aircraft. Their flight characteristics are overly different from flight characteristics of large jets. Stall recovery training is totally absent during a type rating training, line and recurrent training. This is partially caused by majority of flight simulation training devices inability to simulate correctly stall behaviour, such as by general preference for upset prevention training instead of upset recovery training.

The outcome of lack of manual flight beyond stall during pilot career may lead to total inability to recognize and recover from such a situation in instrument flight rules (IFR) conditions after several years. The pilot simply forgets the taught automatic reactions or misunderstands the situation presented by the instruments, even if it is obvious. This situation is particularly pronounced when flying a fly by wire controlled aircraft, where stall is impossible under normal flight control law. These are the arguments for inclusion of upset recovery training into all major phases of pilot training conducted on a simulator, namely the type rating and the recurrent training, and also more extensively into multi crew pilot licence (MPL) training curricula. It is important to know how to avoid upset attitudes, but it is as well important to be able to recover from such conditions if they occur. Therefore upset recovery training may be considered to be the future best practice.

There must be a significant improvement in flight simulation techniques used in flight simulation training devices (FSTD) in order to achieve this goal, but recent achievements in personal computer simulations of modern airliners show us the way to go.

On the other hand, it is imperative for the pilots to know the required theory concerning in-flight upset attitudes and recovery. For this purpose a document was prepared jointly by The Boeing Company, Airbus and the Flight Safety Foundation (FSF) for the USA FAA. [3]

There are also several similar manuals and teachwares from private companies providing theoretical and practical upset recovery training.

Conclusion

Safety of air transport has always been of great concern. Several fatal accidents in the last years show deficiencies in pilot manual flying skills leading to decreased level of safety. This situation may be even exaggerated by multi-crew pilot licence implementation and in greater extent by more complex and more refined automation systems with every new airplane generation. A pilot is actually not piloting, but is instead a systems and computer operator. This, however, decreases pilots' abilities to react on inadvertent changes in automation availability and unexpected indications malfunctions related to spatial orientation in terms of speed, attitude and altitude. Inability to fly the aircraft manually in case of such problems leads to upset and stall situations that could be solved using simple universal methods taught in basic PPL training, but are long forgotten due to insufficient recurrent training and insufficient manual flight experience on edges of the flight envelope. It is imperative to start to think about update to training principles and syllabi in order to incorporate these currently lacking regimes of flight into every phase of pilot training, but mainly type rating training and recurrent training. This may lead to decreased number of LOC-I accidents in future.

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