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ON COMMERCIAL AVIATION SAFETY

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NATS

Scenario Training for Aircrew and Controllers [STAC] – General information

As part of ongoing training undertaken throughout NATS, there is a desire to expand the syllabi of TRUCE and the continuous professional development of operational staff. As part of this development SRG have approved the expansion of the licensing requirement of TRUCE to include more pilot/controller interface activities. These will include controllers joining with pilots to experience LOFTs, and a new workshop-based activity known as STAC.

STAC offers pilots and controllers a forum to jointly explore the risks and hazards inherent in emergency situations, and to promote mutual awareness of the protocols and options to be observed or considered.

The workshops will be facilitated by NATS TRM Specialists and airline CRM instructors and will follow structured discussions relating to:

- Communication issues within the flight-deck and externally with ATC agencies
- Sharing situation awareness in an emergency scenario within and between the two groups
- Issues of overload and decision making for both parties
- Handover issues between controllers, and sharing the situation within and between the aircraft crews
- The use of SOPs, including emergency quick reference checklists by both groups

The workshops will use actual emergency scenarios to help promote increased awareness by all participants of the separate and often competing demands on attention and responses in unusual and emergency situations.

The workshops will be held in a variety of venues including Swanwick, Farnborough and Gatwick. 2012 dates are:

27th June
13th September
17th September
11th October
19th October
25th October
2nd November
6th November

All enquiries about attending these workshops should be directed to

Anne Isaac at anne.isaac@nats.co.uk OR Michele Robson at michele.robson@nats.co.uk

Correction to Page 19 of Focus Issue 86:

- Procedural Service - .... **Radio Procedure:** *'Request Procedural Service'*.
- Traffic Service - .... **Radio Procedure:** *'Request Traffic Service'*.
- Basic Service - .... **Radio Procedure:** *'Request Basic Service'*.

Contents

The Official Publication of THE UNITED KINGDOM FLIGHT SAFETY COMMITTEE ISSN: 1355-1523 SUMMER 2012

FOCUS is a quarterly subscription journal devoted to the promotion of best practises in aviation safety. It includes articles, either original or reprinted from other sources, related to safety issues throughout all areas of air transport operations. Besides providing information on safety related matters, **FOCUS** aims to promote debate and improve networking within the industry. It must be emphasised that **FOCUS** is not intended as a substitute for regulatory information or company publications and procedures.

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What risk?

by Dai Whittingham, Chief Executive UKFSC

I was delighted to take the call from Tony Wride last January in which he invited me to take on the UKFSC Chief Executive role. It was only later that I remembered the conversation I had with Rich Jones last year and my asking him what was the worst aspect of the job. He thought briefly before announcing: "It's writing the editorial for FOCUS every quarter!" He was right – it's not easy to decide what to say when safety has so many aspects to consider.

Let me start by adding my own tribute to those that have already been paid to Rich. I know from contact with the Committee in a previous life that it has been thoroughly transformed with him at the controls, and the high regard in which he is held across the safety community has been readily apparent at the meetings I have attended as the new CE. He also gave me a comprehensive handover, making sure that I had all the necessary information at my fingertips, and he left me with a highly organised office and work plan. Thank you, my friend, you made my first few weeks very easy.

By the time this edition of FOCUS goes to print we will have elected 4 new members of the Executive Board. Tony Wride is standing down after an unprecedented 3 years as Chairman and 2 years as Vice-Chairman; Steve Hull is relinquishing the Vice-Chairman post after 3 years, having been Chairman himself in 2008/2009. Robin Berry is retiring and leaves as Non-executive Board Member having also served as Chairman in 2007/2008, and Tony Barrett-Jolley is retiring as Treasurer having served on the Board since 2005. Steve will remain with the UKFSC and I very much hope we will see guest appearances from Tony W, Robin and Tony B-J at our meetings in the future. On behalf of the UKFSC, I would like to offer our sincere thanks to them for their outstanding contribution to the Committee and in particular for all their hard work with the Executive Board; they will be greatly missed.

You might be wondering what an ex-RAF pilot has to contribute where commercial aviation safety is concerned, and perhaps why the Executive Board decided to take the risk of appointing another military aviator. True, I have never flown an Airbus or a Boeing 737/747/757/767/777 etc, nor do I hold an ATPL. I've not faced commercial pressures, I've not feared for my employment as a result of speaking up about safety and (with a nod to the occasional over-exuberant navigator) I've never had to deal with a disruptive passenger. That said, my involvement in aviation safety goes back almost 30 years – though I must confess when I first started as a flying supervisor that I was still convinced airworthiness was an excuse the engineers used either to stop me flying or having too much fun when I did get to fly! I know a bit more these days and have appropriate respect for the people who work to get us into the air.

However, I do bring some other experience to the job, including time as an instructor, examiner and head of flight crew standards (albeit military). I have been a regulator for flight ops within the MOD system and in NATO, and I have also held airworthiness responsibilities. I have operated as a single pilot, and as both captain and co-pilot on a 4-man flight deck. And when I first started on the AWACS I was in the strange position of being a co-pilot squadron commander, which made me think very deeply about cross-cockpit authority gradients and the example I needed to set in just-culture terms if my juniors in rank were going to stop me getting them all into difficulties while I learned the ropes.

So what did I learn that is relevant in the commercial sector? Amongst other things, I learned (very nearly the hard way) that fatigue can be a killer. I learned that it does not matter who, what, or how experienced you are, any aircraft will bite you if you don't approach the job with care or prepare properly. I learned that when it came to operating large aircraft, the people I had previously dismissed casually as being far too pedantic and risk-averse were actually more professional than I was. And I learned that risk is heavily dependent on context. Let me illustrate this last point.

One of the early training sorties in the AWACS (B-707) was a night trans-Atlantic trip that exposed people like me to Oceanic processes and provided a long transit during which the airborne technicians could practice firing up and shutting down the main mission radar (for which you needed to be at altitude). Having successfully got into the track system, I spent some time adjusting the flight deck lighting in the way I had always done over the previous 25 years – Stygian gloom, with everything at the lowest possible level to avoid threats or potential targets being rendered invisible in the dark. Cue the arrival of a very experienced QFI who gently pointed out that the main risk to us was not mid-air collision or being 'bounced', but the risk of falling asleep because of our Circadian rhythms, low activity level and hence low arousal state. He turned all the flight deck lights up to full brightness and invited someone to bring coffee.

Three years later, I was captain of an aircraft on an operational mission in the midst of the air war over Serbia and Kosovo. As we coasted in, the navigator (yes, we still had them) suddenly turned off the weather radar, the radalt, the TACAN sets and all the external lights. I asked why he had done that and he told me he was reducing our emissions to a minimum because of the fighter threat. To be fair, we were in the most attractive target on either side of the border and there was indeed a fighter threat. I gently pointed out to him - in the manner demonstrated by my QFI - that we had a radar cross-section the size of Yorkshire, that the main radar was producing enough energy to be detected 500 miles away, that the mission crew were transmitting on 12 HF/VHF/UHF radios, and that the main threat to us wasn't being shot down but rather (this time) a mid-air collision with one of the 50+ allied aircraft operating in the same piece of sky! I had all the navaids restored, turned every available external light on, and sent the nav to make some coffee; we went to war looking like an overweight Christmas tree and no-one bumped into us.

The point of both stories is that your assessment of risk needs to consider the context in which the activity takes place. Further, any assumptions or assessments you make need to be tested by others – there is no guarantee that you have covered all the angles or that your conclusions are accurate. I don't want to get into semantic arguments here, simply to observe that analysing risks, hazards or threats can be a painful and laborious process that needs regular revisiting. But if you don't do it, you end up relying on luck. And if you do rely on luck, you can also rely on the fact that it will eventually run out. And then you have to hope you are in the correct corner of the probability vs severity matrix.

"THE TITANIC FACTOR"

by Capt. Tony Wride, Monarch Airlines

In case you haven't read one of my previous columns I expressed my concern about aircraft arriving at destination with minimal fuel as airlines impose tighter fuel policies in the current economic climate. I mentioned the wheels up landing of a B767 blocking a runway and said that whilst such events are rare they can happen. Little did I know that not long after I had expressed my concern, another of those 'rare' events would occur when the runway at Gatwick was blocked by an A330 after an emergency landing and passenger evacuation. All of a sudden a large number of aircraft ended up diverting, fortunately in good weather, and I would love to know what sort of fuel state some of them landed with. At the time I was at Luton, about to depart for Tenerife, and saw a number of unfamiliar aircraft landing there all diverted from Gatwick. I am trying to imagine the increased pressure and stress that the crews faced on the day where a 'fine day out' suddenly turned into a bit of a nightmare as the fuel levels got lower and lower! As the saying goes "There is no greater pressure for a pilot than the lack of fuel pressure"!

So here we have the quandary that faces the Airlines and Safety departments when trying to work out and manage risk. There are a number of things that are either fitted to an aircraft or are carried, "just in case", a particular, but unlikely, event occurs. For example every aircraft carries life vests and some even carry life rafts. How often have large commercial aircraft ditched in the last 20 years? Well until the Hudson river accident not many so you could justifiably put the likelihood of such an event as being extremely unlikely. So why do we still carry life vests? Perhaps we are still suffering from the Titanic effect!

If you now look at the likelihood of having to divert, for anything other than weather, then the likelihood is somewhat more likely than a ditching but aircraft are now being forced to carry less fuel! So the 'just in case' argument applies to some things but not others! Why??

Back in 1912 a group of people claimed that due to its advanced design the Titanic was unsinkable! In their own way they had designed in, what they considered to be, additional safety features to mitigate the risk to the ship in the event of a collision. They thought they had covered all likely scenarios and therefore proudly boasted about the

additional safety of the ship! As a result, the Board of Trade allowed the ship to have an insufficient number of lifeboats with tragic consequences. In a similar way when the Airbus A320 was introduced with advanced protection systems some of the pundits, but I hasten to add not the manufacturer, claimed it was uncrashable! However, as was dramatically proven, no matter how good the design no one can design out the biggest risk to a ship or aircraft, the human one! In the case of the Titanic the decision to continue at speed when icebergs were present proved fatal. In the A320 case the manufacturer had not thought anyone would try and do a low go around at an airfield that operated light aircraft and with trees at the far end!

The whole purpose of having an effective Safety Management System is to try and mitigate all the 'identified' risks to reduce the possibility of an accident/incident. The problem the Safety specialists face is how far do they go when considering the possibilities. Also how far do they go when trying to consider the various permutations and the most difficult factor, the unexpected human one?

If the White Star Line had had a Safety Management System back in 1912 would they have identified a high speed collision with an iceberg as a likely event? They might have considered a head on collision with another vessel or object, including an iceberg, and therefore concluded that the new safety features of the Titanic would mitigate the risk. I believe that the design actually allowed for 5 forward compartments to be flooded without risking the loss of the ship based on a head on collision. Would they have even considered a long gash, caused by an iceberg or whatever, resulting in all those supposed additional safety features being compromised? Would they have considered the human factor of the ship travelling at speed at night in an identified ice field? In a more up to date event would the designers or safety experts have thought anyone would pull back on the controls when an aircraft was stalled?

The unexpected Human input is possibly the most difficult factor to consider when trying to carry out a Risk Assessment. The avoidance of unexpected human inputs, whilst not possible to completely eradicate, can be partially mitigated with effective training coupled with experience. If nothing else should an accident happen then in court a company with a well trained experienced staff will be less open to litigation than one with inexperienced and untrained staff. Before you all think I'm just talking about pilots that's not the case. Our industry relies on a large number of people doing things right and not making errors whether they are Pilots, Engineers, Air Traffic Controllers, or Ramp Staff. An unexpected and unidentified error by any of them has the potential to cause a serious accident.

Those of you who have followed my columns over the last 3 years will know that I have expressed my concerns about where the Commercial Aviation industry is going as a result of the financial pressures. In particular the fact that the industry is going down the road of putting extremely inexperienced pilots in the right hand seat of complex jet aircraft I fear is introducing an unnecessary risk. The fact that the regulators are allowing it could be likened to the Board of Trade in 1912 allowing Titanic to have insufficient life boats, 'just in case'! So consider the following. Why are we not allowing 50 hour pilots to be direct entry Captains? In the event of the experienced Captain becoming incapacitated that 50 hour pilot by default becomes the Captain! So now, the Captain has a 'just in case' inexperienced back up system, and that back up system has no 'just in case' extra fuel to survive the unexpected iceberg! I will leave you with that thought and the ramifications of it.

Safety vs. Security Today

by Stuart McKie-Smith, Safety & Security Adviser – Vistair

The first recorded aircraft hijack was on February 21, 1931, in Arequipa, Peru. Byron Rickards, flying a Ford Tri-Motor, was approached on the ground by armed revolutionaries. He refused to fly them anywhere and after a ten-day stand-off, Rickards was informed that the revolution was successful and he could go in return for giving one of their number a lift to Lima. Most hijackings have not been so farcical.

The aftermath of Pan Am 103 exploding over the village of Lockerbie in Scotland on 21December 1988, killing 270 people, showed that, in spite of attempts by many countries to introduce some security systems, what they were doing was just not enough. The Lockerbie incident had a particular effect on UK aviation security, and saw the introduction of hold baggage screening on a far greater scale than before, together with other checks.

The attacks on the World Trade Centre on 11 September 2001, brought a new global focus on aviation security, and within that focus, special attention to the possibility of aviation being used as a means of attack, as well as the object of it. This has driven security enhancements designed to reduce the risk of hijack, notably the fitting of secure cockpit doors and a growth internationally in the use of "sky marshals".

Before the September 11, 2001 attacks, crews advised passengers to sit quietly in order to increase their chances of survival. An unofficial protocol emerged in which civilians and government authorities understood that in most cases, violence from the hijackers was unlikely as long as they achieved their goal (often, as during the rash of American incidents in the 1970s, a trip to Cuba). This was also the basis for all aircrew training, and cabin crew in particular, were encouraged to interact with the hijackers in an attempt to prevent escalation of violent acts.

The situation has changed

Since the September 11th attacks, survival for passengers and hijackers is different. As in the case of United Airlines Flight 93, where an airliner crashed into a field during a fight between passengers and hijackers; passengers now have to calculate the risks of passive co-operation, not only for themselves, but for those on the ground. Future hijackers may encounter greater resistance from passengers, making a hijacking more unlikely but, if they happen, bloodier. An example of active passenger resistance occurred when passengers of American Airlines Flight 63 from Paris to Miami on 22 December 2001, helped prevent Richard Reid from igniting explosives hidden in his shoes. More recently, Umar Farouk Abdulmutallab attempted to detonate plastic explosives hidden in his underwear.

Passenger reactions were unilateral, immediate & aggressive

This creates a dilemma for cabin crew. They now have to balance the choice of help when dealing with these situations, against escalation of events that may lead to innocent deaths, and possible legal action.

Several countries have stated that they would shoot down hijacked commercial aircraft if it can be assumed that the hijackers intend to use the aircraft in a 9/11-style attack, despite killing innocent passengers onboard. According to some reports, US fighter pilots have been training to shoot down hijacked commercial airliners should it become necessary.

Other countries, such as Poland, have enacted laws or decrees that allow the shooting down of hijacked aircraft.

One of my roles in the aviation industry was Head of Security for the UK regional airline, Flybe. I also managed Flight Safety for this company for a number of years, and was fortunate enough to be associated with the UK Flight Safety Committee as both a member, Vice-chairman and subsequently Chairman. It has therefore been interesting for me to see both sides of the argument as to how security can affect Flight Safety.

We have obviously had our own problems in the UK, including the possible use of liquid explosives in hand baggage, leading to extra measures being put in place to combat this threat. Apart from the confiscation of huge amounts of toiletries and drinks from crews who had either forgotten about the rules, or who had not read them properly (taking away a girls make-up, whatever their profession, is not a wise move in any circumstances!), searching of the individuals by enthusiastic security personnel all adds to the frustration.

So what's the big deal, after all we are talking about professional people who can overcome these irritations? Well, not necessarily.

Of course all crews are professional and are used to dealing with all manner of events. Pilots spend hours practising emergencies, cabin crew spend hours with the general public over issues that would have any normal person ready to commit murder! They take great pride in their standard and delivery of work, and there has to be some expectation of recognition by their colleagues in the airline industry. We are now in the "Catch 22" situation as one cannot exist without the other. We perhaps need to try a little harder. So what are the issues? My experience is mainly concerned with the UK, but many of the issues are global. Here are just a few of them, and in no particular order:

- Aircrew are being treated as part of the problem
- Too many rules to be read
- Variations between airports on interpreting regulations
- Inconsistency of security screening by airport staff
- Restricted access to Flight Deck for training
- No face-to-face contact between pilots/cabin crew

In the UK, full airside (Critical Part) pass holders have to undergo a Criminal Record Check (CRC) and a 5 year employment history with no unaccounted gaps of more than 28 days. Having completed this in-depth look at an individual they can then be issued with an 'airside' pass. But getting to airside can be a major task in itself!

Security staff are under constant pressure from airport management to ensure compliance and to keep the DfT from the door. These pressures can sometimes, in their enthusiasm to comply, lead them to forget that they are part of the airport and its customer service team. If the essential personnel are denied access, or their access is made more difficult than necessary, then we have to look seriously at not only the effect of

Flight Safety, but also the effect on commerce. This is not to say that security staff should be allowing anyone through dressed as aircrew (or other airside workers for that matter), but perhaps more allowance and recognition should be made for the people who are going to be the last guardians of security before flight.

I had many complaints from aircrew concerning security staff almost 'making an example' of crews at the search point. This is particularly difficult for young female cabin crew with their underwear out on the table for inspection and all to see! This sort of event can be regarded as one of the first steps in a chain of distractions that can lead to a Flight Safety issue.

Arriving at the aircraft, having been subjected to yet another embarrassment, does not help one start the flight in the right frame of mind. Some aircrew are even anxious about going through the search cone, even though they have nothing to hide. More experienced members will take it all in their stride, but only to a point, and is it really necessary?

Of course we must mitigate the risk of any threat to the aircraft from terrorism, but we also need to be aware of those who pose a risk and those who do not.

The vast number of regulations, changes to them, local interpretations and directions from companies (airlines, airports, service providers etc.) do little to improve relations amongst staff in the environment. All of the agencies at the airport have a part to play in ensuring smooth flow for all, from check-in to departure. Flight Safety is not just an aircrew prerogative. We rely on everyone who is at the airport to help us keep flying safe. We must, however, be careful not to overwhelm them with security considerations at the expense of Flight Safety. In the past it is probably true to say that security came second on the priority list – times have changed, and we now need to look at both Flight Safety and Security in the same sector.

Once past the security gauntlet, and having arrived at the aircraft, the 'Flight Safety vs. Security' effect does not stop. Safety and security checks must be completed. One has to ask the question, given short turnarounds and commercial pressure by airlines (and airports) to make the slot time, are some of the checks being given full attention? It was perhaps a rush before, but what happens now?

Do you know what happens on all your aircraft with all your crews?

Once airborne, having completed all the security checks, the crew's then settle down to the routine of flight - but it's not that routine any more. Apart from the added pressure of watching their charges for any signs of suspicious behaviour, the additional security arrangement is of course, the hardened cockpit door. The majority of the contact between the cabin crew and flight deck must now be carried out over the interphone. Not an easy transition for those of us who like to see who we are talking to. When a high stress level situation occurs, particularly one involving Flight Safety, it is vital that crews communicate effectively and accurately. Training can give some guidance but can only be tested with the 'real thing'. There are some advantages to the locked cockpit door policy – Standard Operating Procedures (SOPs) must be used to ensure that we all know what we are doing, or expecting from others. The obvious disadvantage being that we can learn far more about a situation by face-to-face dialogue, than we ever can over the 'phone.

It is also interesting to note that the hardened cockpit doors have airflow slots in the event of explosive decompression. These slots can let in light at night, noise during flight, and, depending on the position of the toilets, some unwanted odours!! These also can add to distraction.

It is interesting to note that our American cousins have taken a more pragmatic approach with their crews and, since '9/11' have a far more relaxed attitude towards aircrew not only passing through security, but sitting on the Flight Deck, and inter-airline rides for uniformed crews.

What about the passenger contribution?

I have had the opportunity over the years to become a close observer of passengers and their potential to be disruptive. Although we in the Air Transport sector do not think there can ever be any justification for bad behaviour on board, we never know what they have been through to get them to the airport for the start of their flight. Last minute delays at home, rotten weather, stressful drive in, parking what seems like miles from the airport, rain (I am talking about the UK!), the arrival at departures to be confused by signage, the check-in staff at the end of an all night shift – I could go on. Then the attempt to get to the departure lounge via the security gauntlet, and the probable loss of all the cosmetics and other liquids that they either forgot they had, or never read about. The security experience may see passengers arrival at the aircraft in no mood for pleasantries! This adds more pressure to the crews who may well be concentrating more of their attention on these passengers than other more important safety considerations.

I do not wish to give the impression that security is not an important part of our daily life in the Air Transport business – far from it. Security is good – it keeps us safe and should give crew, staff and passengers, the confidence to fly from any airport knowing that measures are in place to protect them. We must, however, maintain an even balance between what is necessary to reduce the risks of terrorism, against what is also necessary to maintain safe flying. It is a difficult call. If the aircrew (and others involved with aviation) are spending too much time being distracted by security requirements, what is the effect on Flight Safety?

The argument for carrying out the same security checks on aircrew as everyone else, is often given that they may be subject to pressure against their families or they may have be suborned. I find this a difficult reason to follow given that once they are the other side of the locked cockpit door, they can do what they like. They have a handy axe to help them and a big lump of metal full of fuel if they feel the need to create havoc!

So is there really a problem? I believe there is, but it is not that simple or transparent.

Airspace – a strategy for the future

by Civil Aviation Authority

The basic structure of the UK's airspace - the routes aircraft fly and how airspace is allocated between users such as airlines, military and private aircraft - was developed over forty years ago. Over this period there have been huge changes, including a hundred-fold increase in demand for aviation.

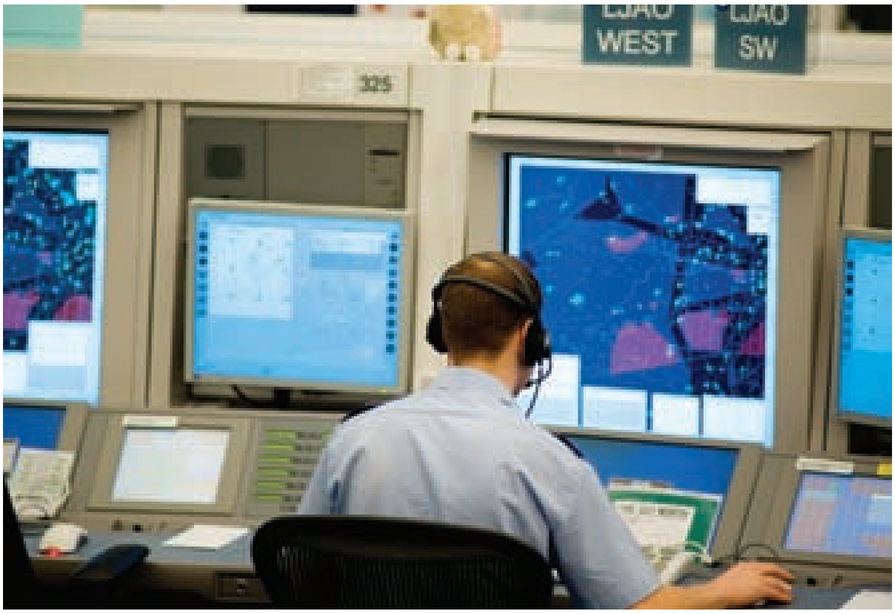
The Civil Aviation Authority has therefore developed a 'Future Airspace Strategy' to map out demand and identify technological imperatives. Drafted in cooperation with the Department for Transport, Ministry of Defence, NATS and key aviation stakeholders, the Strategy aims to address the structured development of our airspace right through to 2030. It determines the key characteristics of a proposed airspace system and sets out many of the changes required to deliver it, identifying policy and regulatory requirements that support and enable their introduction.

It is worth pointing out, of course, that the UK has an excellent aviation safety record, underpinned by high safety standards and the professional dedication of those who use and manage UK airspace. If we are to maintain, and indeed improve, this record then it is another driver for a new airspace strategy. Also, the environmental impact of aviation, including greenhouse gas emissions, has now, rightly, to be taken into consideration. A new plan will also help in this respect by increasing the efficiency of our system. And in creating greater airspace capacity, a balance must be struck between the requirements of airspace users - commercial airlines, general aviation and the military – and the wider social concerns.

There are essentially four key drivers that affect the efficiency of the UK's airspace arrangements: growth in demand; the environmental impact; the future development of airports; and the introduction of new technology.

Looking at demand first. Although commercial aviation has been badly hit as a result of the economic slowdown, demand remains reasonably high, with around 2.3 million annual passenger air transport movements in UK airspace. There is a clear correlation between growth in demand for air transport and economic growth, so the number of movements in UK airspace is likely to resume its upward trend in line with economic recovery. The military, on the other hand, need to maintain operational effectiveness through access to appropriately sized and sited airspace. Whilst the total numbers of military aircraft may have reduced over time, the performance and training requirements of modern aircraft and weapons systems demand greater volumes of airspace. Military aircraft currently deployed overseas will of course return to the UK at some stage as operations come to an end, increasing the size of the domestic fleet. General Aviation, meanwhile, is a diverse sector encompassing business aircraft through to private pilots operating a range of light aircraft including microlights, gliders and balloons. Overall, general aviation activity is expected to continue to grow out to 2030 and with it the demand for access to uncontrolled airspace. The number of light aircraft on the UK register continues to increase with microlights in particular surging in popularity. The pattern of demand is also likely to change - there is potential for an increase in the use of Very Light Jets to serve the personal and air taxi market, and unmanned aerial systems for both civil and military applications.

Aviation's environmental impact, both locally in terms of noise and air quality and globally in terms of climate change, is a key consideration in the design of airspace arrangements. Initiatives such as the development of more fuel-efficient engines and work on bio fuels, should serve to mitigate the impact of aviation, as will instruments such as the Emissions Trading Scheme and the introduction of targets to reduce CO2 emissions. The need to provide airspace arrangements that have the minimum practicable environmental impact is likely to involve a degree of trade-off between, for example, noise and CO2, to achieve the optimal outcomes.



New technology will play a key role in determining how airspace arrangements might evolve. The Single European Sky Air Traffic Management Research (SESAR) programme is a pooling of current research and development efforts that aims to develop a pan-European ATM system optimising the benefits of new technology. The project is currently in its development phase, with implementation covering the period up to 2025, and the UK is actively engaged with, and committed to, this major programme to ensure that the timing and scale of technological changes are matched by changes to the UK's airspace arrangements. Investment in any new technology needs to be accompanied by clearly identified benefits and a viable safety case, as both airports and airlines will be unwilling to invest unless a return on investment is clearly evidenced. The aim will be to enable a collaborative approach to deliver common benefits across the ATM system without entailing significant additional up-front investment or undue risk.

It is clear that changes to the airspace system cannot be considered in isolation. Many desired airspace changes will have a European or international context and even when purely a national issue, they will invariably involve more than one airspace user group. Almost every change will have an environmental, safety, economic and national security dimension to consider, underpinned by emerging technological innovations.

The Future Airspace Strategy determines how best to align with and exploit the operational and technological enablers, coming from external influences like SESAR, and implement them to achieve the greatest potential benefits for the UK. Due to the degree of uncertainty associated with future airspace developments, the strategy must remain flexible. It can therefore be viewed as the development of a framework of options that will assist us in determining how the planning, management and regulation of our airspace should evolve depending on the circumstances.

Exploiting new technology is particularly important. Advances in the way aircraft navigate and communicate with controllers – particularly direct data transfer rather than voice communications - integrated with increasingly advanced computer tools for air traffic controllers, will allow increases in capacity and efficiency. The aim is to utilise PBN capabilities within the TMA to design routes that are systemised and programmable and that do not rely on tactical intervention by ATCOs. Procedures will be optimised for continuous climbs. Away from the TMA, more flexible and direct routes meanwhile, will allow pilots and controllers to reduce delays and increase efficiency – reducing the amount of fuel burnt and therefore reducing the environmental impact. Sharing systems, technology and airspace across Europe will also have a significant impact. The removal of national boundaries in the air, together with systems that are incompatible and duplicated and procedures that change from country to country will allow a more seamless and efficient system for aircraft to use.

The proposals outlined in the Future Airspace Strategy aim to produce significant benefits not just in the obvious realm of safety, but also through enabling air navigation service providers to supply additional airspace capacity while minimising the expansion of controlled airspace. It will additionally reduce aircraft greenhouse gas emissions and noise and also allow users and suppliers to operate in the most cost effective way possible.

For more information on the CAA's Future Airspace Strategy please go to: www.caa.co.uk/FAS.

High-Altitude Upset Recovery

Radical revisions needed for pilot training, aircraft certification and simulator fidelity

by Fred George

Investigators with the French Bureau d'Equetes et d'Analyses (BEA), the agency charged with investigating the crash of Air France Flight 447, now are focusing on a breakdown in situational awareness on the part of the flight crew and possible pilot error as contributing factors in the June 2009 mishap that killed 228 people when the Airbus A330 crashed into the South Atlantic. The latest findings broaden the scope of the inquiry well beyond a fly-by-wire flight control malfunction, possibly caused by iced-up pitot probes.

While the BEA is far from completing its investigation of the AF447 accident, its most recent progress report again focused the aviation community's attention on the perils of loss of control (LOC) incidents, especially at high altitude. This is a multifaceted challenge because improved stick-and-rudder skills are unlikely to eliminate the problem entirely.

"The Air France 447 crash was a seminal accident. We need to look at it from a systems approach, a human/technology system that has to work together. This involves aircraft design and certification, training and human factors. If you look at the human factors alone, then you're missing half or two-thirds of the total system failure," says C. B. "Sully" Sullenberger, a 20,000-hour retired airline pilot and former fighter pilot.

Celebrated for his successful ditching of a powerless A320 in the Hudson River, Sullenberger is now a writer, aviation consultant and public speaker. He notes that there were 12 or 13 similar upset mishaps prior to AF447 in recent years, but that Air France 447 has attracted the most public interest. Sullenberger says that there needs to be a global safety reporting network that will enable the aviation industry to identify problems more quickly and find solutions.

Sullenberger says it's easy to blame the pilots in the AF447 crash while overlooking other contributing or causal factors. "I believe the transport airplane community, as a whole, would not expect the crew to lose all three speed indicators in the cockpit," he said. "That's like amputating the wrong limb in a hospital" because critical information was not available.

He also believes that accurate airspeed indications alone aren't the best data the crew needs to recover from an upset. That requires knowing the wing's critical angle of attack (AoA). "We have to infer angle of attack indirectly by referencing speed. That makes stall recognition and recovery that much more difficult. For more than half a century, we've had the capability to display AoA (in the cockpits of most jet transports), one of the most critical parameters, yet we choose not to do it."

Training also needs improvement. "Cur rently, to my knowledge, air transport pilots practice approaches to stalls, never actually stalling the aircraft. These maneuvers are done at low altitude where they're taught to power out of the maneuver with minimum altitude loss." In some aircraft, they're taught to pull back on the stick, use maximum thrust and let the alpha floor (AoA) protection adjust nose attitude for optimum wing performance.

"They never get the chance to practice recovery from a high-altitude upset," he continued. "At altitude, you cannot power out of a stall without losing altitude." And depending upon the fly-by-wire flight control system's alpha floor protection isn't the best way to recover from a stall at cruise altitude.

Maintaining situational awareness is another challenge in highly automated aircraft. "There are design issues in some aircraft that I've always wondered about," Sullenberger said. "For instance, I think the industry should ask questions about situational awareness and non-moving autothrottles. You lose that peripheral sense of where the thrust [command] is, especially in a big airplane where there is very little engine noise in the cockpit.

"In some fly-by-wire airplanes, the cockpit flight controls don't move. That's also part of the peripheral perception that pilots have learned to pick up on. But in some airplanes, that's missing and there is no control feel feedback," he said.

Loss of Control – A Continuing Problem

Of the 89 fatal commercial airline accidents that occurred from 2000 to 2009, 20 mishaps indeed involved inflight LOC. More than 1,800 people perished in these crashes, according to data presented by Mike Coker, Boeing's senior safety pilot, at the Flight Safety Foundation's 23rd annual European Aviation Safety Seminar in March 2011.

Safety experts note that stalls, among other LOC events, now have become the leading cause of fatal accidents in jet transports, outranking controlled flight into terrain events by a four-to-three ratio.

Most LOC accidents or incidents occur at low altitude, often occasioned by a complete aerodynamic stall of the airplane. Historically, stall recovery maneuvers have been taught at low altitude, both in simulators and aircraft. Pilots have rehearsed initiating stall recovery at the first sign of an impending stall, most often when an aural or tactile pre-stall warning device is triggered. The aircraft never reaches its maximum lift coefficient, let alone departs from controlled flight.

At low altitude, turbine engines produce a surfeit of thrust that enables pilots to power out of the pre-stall maneuver with a slight reduction of AoA resulting in minimum altitude loss. Pilots have been taught this technique during decades of initial and recurrent training. However, Coker noted that “approach to stall’ training is a scripted maneuver” with “limited and non-realistic scenarios.”

Even though their pilots underwent regular pre-stall recognition and recovery training in simulators, FAR Part 121 air carriers suffered four low-altitude LOC mishaps between 2004 and 2009, all of which may have been prevented by the crew’s prompt initiation of stall recovery procedures at the first indication of stall warning. “Most approach to stall incidents and accidents occur with sufficient altitude available for the recovery,” Coker’s presentation stated.

Coker noted that there was a 2007 near disaster involving a Thompsonfly Boeing 737-300 during which the crew failed to maintain proper airspeed after an uncommanded autothrottle disengagement. In 2008 and 2009, there was a stall-related crash of a Colgan Air Dash 8 Q-400 near Buffalo, N.Y., an LOC accident involving a Turkish Airlines B737-800 near Amsterdam, and XL Airways of Germany lost an A320 of the coast of Perpignan, France, apparently because of a low-altitude stall at 3,800 ft. with 57 deg. of nose-up pitch attitude and 40 KIAS airspeed.

Notwithstanding the limitations of lowaltitude stall recovery currently practiced in simulators, if those crews had immediately used their well-rehearsed stall recovery procedures at the first indication of LOC, those mishaps could have been prevented. Airbus, for instance, concluded that current simulator training, while having significant limitations, remains an effective means of teaching crews how to recover from low-altitude stalls.

Pilot techniques that are effective for-low altitude stall recovery, however, are blatantly inappropriate when attempting to regain control after a high-altitude upset. This became quite clear during the investigation of the 2004 crash of a Pinnacle Airlines CRJ-200 and the 2005 crash of a West Caribbean MD-82, both of which started with high-altitude upsets. BEA’s new focus on a high-altitude stall as being a prime factor in the AF447 crash also has renewed attention on the need for highaltitude upset recovery training.

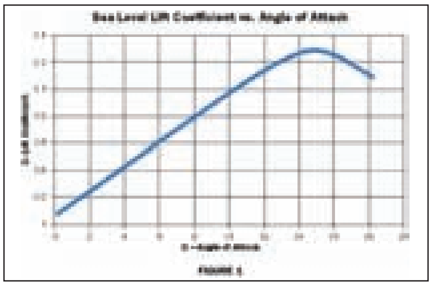
However, initial and recurrent simulator training for civil jet pilots, including corporate pilots, doesn’t include recognition, prevention and recovery from highaltitude aerodynamic upsets.

Claude Lelaie, Airbus’s senior experimental test pilot, agrees. He points out that civilian pilots without prior training in military jet aircraft are “not familiar with high Mach buffet,” yet in some aircraft “buffet may be the first stall identifier at altitude.”

High-Altitude Aerodynamics and Available Reserve Thrust

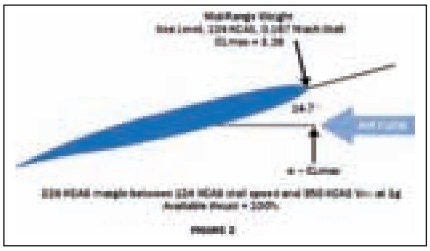
Glance at most aircraft flight manuals and you’ll find a stall speed chart that enables pilots to enter the aircraft’s weight and high lift configuration so as to derive stall speed. One popular business aircraft, for instance, stalls at 105-133 KCAS in the clean configuration at sea-level according to the AFM.

One popular myth is that the aircraft will stall at the same AoA and indicated or calibrated speeds regardless of altitude. That’s simply not true, according to David Lednicer, chief of aerodynamics as Raisbeck Engineering.

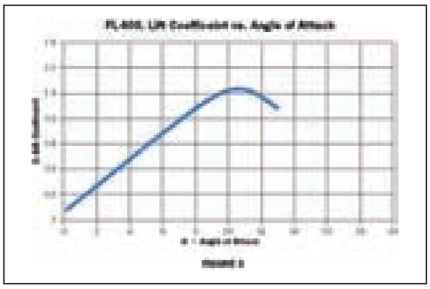


“At low altitudes and low speeds, air behaves as an incompressible fluid,” he explains. In the clean configuration, the lift coefficient of most wings varies about 0.08 for each degree of AoA, up to the maximum lift coefficient. A representative swept wing could have a stalling AoA of 14.7 deg. and generate a maximum lift coefficient of 1.28, as illustrated in **Figure 1**. A sample aircraft at mid-range weight would stall at 124 KCAS in the clean configuration, as shown in **Figure 2**. To power out of a stall at very low altitude, nearly 100% of takeoff rated engine thrust is available and use of high lift devices can increase lift coefficient to hasten stall recovery.

In addition, there is a 226-kt. spread between the 124 KCAS stall speed and the 350 KCAS Vmo redline. This provides a wide range of cruise speeds that provide adequate structural and aerodynamic margins assuming g load factors, known as (n) to aero engineers, are respected.



“But at cruise speeds typical of highaltitude flight, compressibility must be considered. The lift coefficient curve varies as an inverse function of the square root of the true Mach number, among other factors. As a result, maximum lift coefficient is reached at a lower angle of attack during high-altitude cruise,” Lednicer says. Importantly, compressibility becomes a factor as low as 0.25 true Mach number. Most civil jets cruise between Mach 0.65 and 0.85.



Lednicer estimates that the same wing that generates a maximum lift coefficient of 1.28 at Mach 1.87 at sea level will only produce a CLmax of 1.05 at Mach 0.480 at FL 400, as illustrated in **Figure 3**. That’s because compressibility produces significant changes in the airfoil pressure distribution and shock waves cause airflow to separate from the wing, thereby limiting the maximum lift coefficient.

As the free stream Mach number is increased, the aircraft CLmax goes down. Plainly put, while cruising in the flight levels, the aircraft has lower critical angles of attack, higher stall speeds and narrower margins between stall and redline.

Automation and Ennui

Pilots often characterize flying as "hours and hours of boredom, occasionally punctuated by moments of terror." Modern cockpit automation increases the risk that pilots will be lulled into a dull state, unaware of subtle changes that may portend increasing risks.

"The role of the crew has evolved with cockpit automation," says Robert "Key" Dismukes, Ph.D., a former human factors lead scientist at NASA Ames. "There is less hands-on flying and more monitoring. This has introduced new risks because humans are terrible monitors. Their brains are wired to detect changes. If nothing changes, then we can't keep track of what's going on. We're watching for something that might happen, but things can happen so infrequently that they are hard to detect."

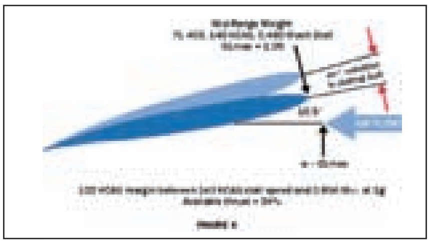
"Anything that takes you out of the active control loop means that it takes you longer to get back into it," he says. Simply put, cockpit automation can make pilots "fat, dumb and happy." Dismukes believes that cockpit automation needs to be better designed to keep pilots in the loop, but he offers no specific recommendations.

Most of the time, the automation is so reliable that being out of the loop doesn't jeopardize safety of flight. Dismukes, though, would like to see better training for pilots, but acknowledges "this involves a cost benefit tradeoff. There is some limit to what training can do to overcome shortcomings in aircraft design."

It's easy to discuss high-altitude upset recovery from the comfort of a classroom on the ground. There is no sudden shock and stress to short-circuit the decision-making process. But if something suddenly goes wrong, such as loss of control, then, he says, "the most learned response kicks in." If pilots are taught to hold nose attitude and power through the stall, then their "motor/sensory responses" become primary.

That can result in fatal errors when trying to recover from a high-altitude upset.

Very few civil aircraft have full flight envelope, Mach compensated AoA indicators, and thus pilots must estimate AoA from indicated airspeed. As shown in **Figure 4**, the sample aircraft's reduced stalling AoA at FL 400 results in a stalling speed of 140 KCAS, which is almost 13% faster than at sea level. The speed margin from stall to Mmo is 122 kt., close to half of what it is at sea level. Notably, the sample aircraft's engine produces only 24% of takeoff rated thrust. Thus it's not possible to power out of a stall or perhaps even out of pre-stall buffet without reducing AoA and losing some altitude. Those extremes aside, the flight envelope regime that is totally free from low-speed or high-speed buffet at FL 400 is much more restrictive. The Mach number of the airflow over the wing is a large factor in determining shock-induced separation and therefore buffet boundaries.



As AoA or lift coefficient increases, the speed of the airflow over the wing increases. At a certain local Mach number, shock-induced separation causes buffet and then stall. Reducing AoA slows the airflow and diminishes the shock wave, thereby allowing the airflow to reattach to the airfoil.

Similarly, as the free stream Mach number of the aircraft increases, so does the local Mach number of the airflow over the wing. At some point, this causes shockinduced separation and buffet.

The margin between the low-speed and high-speed buffet boundaries is illustrated by the Buffet Onset Envelope in **Figure 5**. For our sample aircraft weight, the minimum is 195 KCAS/ Mach 0.67 and the maximum is 242 KCAS/ Mach 0.83 for the sample aircraft weight, resulting in a 47 KCAS spread to maintain buffet free flight in 1g (smooth air conditions). As shown by the green arrow, the peak buffet margin is Mach 0.77 for the sample aircraft. Cruising slower or faster diminishes Mach buffet margins.

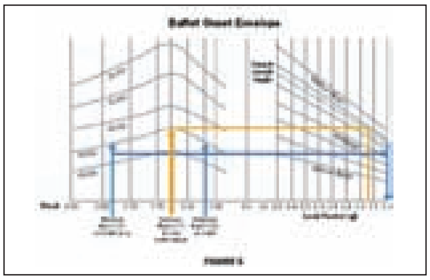


Figure 5 also shows that the buffet onset envelope has wider margins at lower cruise altitudes. At 40,000 ft., for instance, the sample aircraft has a 1.3g peak buffet margin, but at 35,000 ft. there is 1.8g available before the aircraft encounters buffet.

Upset: High-Altitude Aerodynamics and Meteorology

High-altitude turbulence, caused by the jet stream, mountain waves or convective activity, among other weather phenomena, has a significant impact on aerodynamic performance while cruising in the flight levels.

Multiple weather reporting stations and networks of weather radars provide air traffic controllers with critical information to warn pilots about areas of hazardous weather over land masses. In the U.S., pilots also have access to XM satellite weather, perhaps one of the most important advances in hazardous weather avoidance since the advent of aircraft weather radar.

However, there are far fewer resources to provide advance warning of hazardous weather when flying oceanic routes. Coast weather radars cannot detect convective activity beyond line-of-sight range.

Weather reporting stations may be sited hundreds of miles from jet routes. Satellite imagery can spot cloud buildups to provide pilots with preflight planning guidance, but most crews don't have access to midflight updates.

Such limitations are especially important to consider when transiting the intertropical convergence zone, the area near the equator where the northern and southern trade winds collide so as to create strong updrafts that are conducive to convective activity. When combined with warm sea temperatures and solar heating, the updrafts can foment small, but strong storms. Such storms typically are short in duration, but they yield particularly heavy rainfall. The U.S. National Weather Service estimates that four in 10 tropical rainfall rates are in excess of 1 in. per hour.

Being aware of convective activity in the tropics is acutely important to pilots because the velocity of vertical wind shears can exceed 6,000 ft. per minute in the tops of storms or even above the cloud tops. Over hot land masses or very warm shallow water, thunderstorms may reach 65,000 ft. or higher. When operating an aircraft far from land-based weather reporting stations, the onboard weather radar is the only real-time weather avoidance technology available to the flight crew.

Gust loads created by such storms have the potential to create g forces that can spike AoA, thereby increasing local Mach speed over the wing, resulting in shock-induced buffet or even stall. If the gust loads are strong enough, shockinduced airflow separation can occur up to and beyond Mmo. Thus gusts have the potential to create a high-altitude "coffin corner" in the flight envelope, a point at which low-speed stall and Mmo coincide.

Considerable changes in outside air temperature also can be encountered during high-altitude cruise, says William Voss, CEO and president of the Flight Safety Foundation. Static air temperature (SAT) may increase by as much as 20 deg. on the downwind side of a line of thunderstorms. Higher SATs increase the speed of sound and thus the same indicated airspeed results in a lower cruise Mach number. This increases the indicated airspeed needed to maintain peak Mach buffet margins.

High ambient temperatures also can reduce available engine thrust. Thus when more thrust is needed to reach the peak Mach buffet speed at a particular altitude, there may not be sufficient thrust to do so. Airspeed actually can decay below the low-speed buffet margin and the aircraft may not be able to maintain level flight.

In order to prevent a potential clash between high-altitude aerodynamics and high-altitude meteorology, pilots need to be familiar with both the Buffet Onset Envelope chart and available cruise thrust charts in the AFMs. If it becomes necessary to transit an area of turbulence, they need to know how much buffet margin is available at each flight level, what speed they need to maintain for peak buffet resistance and whether the engines can produce enough thrust to hold that speed.

If severe turbulence is encountered, it may be necessary to descend to a lower flight level where the Mach buffet margins are greater and the engines are capable of producing sufficient thrust to maintain that speed in rough air.

Such high-altitude upset prevention measures would be significantly more difficult if the aircraft's air data system were to malfunction. The crew might not have airspeed, altitude or vertical speed indications, making it virtually impossible to maintain the optimum speed and altitude for buffet onset resistance or even stall prevention.

In light of that possibility, it's essential to be aware of the aircraft's nose attitude and engine rpm and fuel flow in normal cruise, says Robert Agostino, former head of Bombardier flight operations and founder of the firm's acclaimed Safety Standdown program. "Most aircraft fly at about 2.5 to 3.0 deg. of nose-up pitch attitude in cruise. If you know what the cruise rpm and fuel flow settings are for the engines, you can usually maintain control. Pitch plus power equals performance," he said.

Some airliner manufacturers offer even more basic advice, according to Voss. There needs to be an automatic reaction when what you see doesn't match what you expect. "If everything else fails, hold 5.0 deg. nose up, level the wings and push the throttles to the climb detent," says Voss. "You may gain or lose altitude, but the aircraft will keep flying."

Critical Need for Angle of Attack Indication

The Air France 447 tragedy might have been avoided if the flight crew had a display of critical and rudimentary aerodynamic performance data. That is angle of attack (AoA), the geometric angle between the mean chord of the wing and the relative airflow.

French accident investigators now suspect that the aircraft was stalled from nearly 38,000 ft. until it crashed into the sea, based upon flight data recorder information. This means that the aircraft wing reached, and then exceeded, a known stalling AoA. The report states that the AoA was 35 deg. as the aircraft descended rapidly to the ocean surface.

Stall recovery in transport aircraft is taught in simulators in level flight by referencing airspeed and altitude, with such maneuvers being performed at low altitude and without turbulence. Heavy emphasis is placed on flying canned stall recovery maneuvers. Recovery is initiated as soon as stall warning indications are reached. At the first sign of stall warning, the pilot is expected to power out of the stall, with minimum altitude loss. Nose attitude, indicated airspeed and altitude are the primary references.

With an abundance of thrust available at low altitude, this stall recovery method serves pilots and the public well, assuming both airspeed and altitude information are correct and available. Unfortunately, almost all these conditions were different aboard Air France 447. At high altitude, the stall speed was higher, the critical AoA was lower, and there was insufficient thrust to power out of the stall without losing altitude.

The Air France 447 pilots correctly recognized that they had erroneous airspeed indications, but they rapidly became disoriented on that dark and turbulent night lacking critical aerodynamic performance information. If an AoA display had been available, the pilots might well have recognized that the aircraft was approaching a high-altitude stall. That would have enabled them to correct the aircraft flight path so as to prevent the stall.

I believe that all transport aircraft manufacturers should display AoA to the crew. The indication needs to be adjusted for Mach and density altitude so that pilots have accurate information about stall margins, cruise performance and appropriate reference V speeds for airport operations.

Measuring and displaying AoA is not expensive. It can be determined by stand-alone sensor vanes or probes, "smart" air data probes or air data/inertial reference systems. Many transport category jets already have AoA sensors, but they're only used for stall warning. The pilots only have limited access to AoA information, yet the flight data recorder aboard AF447 logged a peak AoA of 35 deg. Obviously the aircraft was stalled. Why was critical AoA data not available to the crew? If it had been, perhaps 228 people would be alive today. **By Marty Rollinger**

Marty "Rollo" Rollinger, is a retired U.S. Marine Corps F/A-18 pilot, test pilot and engineer, with 15 years of military flying experience.

Every time he flew the Hornet, he referenced his cockpit AoA display. He currently flies a business jet that does not display AoA information, a shortcoming that he believes ought to be remedied.

Such pitch/power/performance techniques enable the crew to stabilize the aircraft during most instrument malfunctions, providing time to sort out and best solve the problems.

Trust, But Verify; Exercise PIC Authority

"I tend to use automation to its fullest capabilities, but ultimately every airplane is an airplane at its core and it must be flown by a human pilot," says Sullenberger. "How many levels of technology do we want to interpose between the [pilot's] mind and the control surfaces? Those levels must be most appropriate for a specific situation."

There is general agreement among experienced pilots regarding the limitations of highly automated aircraft, especially models with fly-by-wire flight controls. During any LOC event, Lelaie advises to immediately disconnect the autopilot and autothrottles, "apply nose-down pitch control to reduce angle of attack," level the wings, use thrust as needed, ensure that the speed brakes are retracted and carefully recover nose attitude to achieve the appropriate flight path.

"Pilots are intelligent people. But aircraft designers thought that cockpit automation is better than pilots," observes Agostino.

As a result, he says if pilots are not "thoroughly trained to recognize and prepare for such risks, they're lulled into thinking that nothing can happen.

"I want a button on the panel that allows me to disconnect all the automation and that gives me the final say," he concludes.

Agostino is one of many experienced pilots who believes that, regardless of one-in-a-billion probability of failure, flight crewmembers need to be prepared to exercise pilot-in-command authority, disconnect the automation, reduce AoA or even unload the aircraft to near zero g and accelerate to a safe recovery speed.
Sullenberger agrees. "As an industry, we are designing airplanes, training systems, policies and procedures that make it more difficult for human pilots to intervene.

They're out of the loop," he says. "Policies and procedures often encourage or require the use of automation."

Pete Reynolds, veteran general aviation test pilot, said it's difficult to tell whether you've encountered low-speed or highspeed buffet at altitude, especially with the autopilot engaged. But if you disconnect the autopilot, lower the nose to reduce AoA, break the stall and then ease up the nose while maintaining at least 200 KIAS, most aircraft will recover to stable flight.

Many aircraft also have a flight path vector or flight path marker symbol on the PFD or HUD. It's the next best thing to an AoA gauge for stall recovery. If nose attitude is aligned with the flight path marker, AoA and g load will be reduced, thereby enabling the aircraft to accelerate as fast as possible for an expeditious stall recovery.

Pilots routinely get unusual attitude recovery training during simulator rides, but few if any Part 121 or Part 142 training organizations provide high-altitude upset or stall recovery training. It's simply not part of the required syllabus. And full-flight simulators typically aren't programmed to replicate high-altitude stall behavior even if it were required for training.

"There are so many risks that we flag during training, but we don't flag the risk of high-altitude upset. We have really undertrained this one. I definitely think we need more training in high-altitude aerodynamics and meteorology," comments Voss. "[Civilian] Pilots just don't get high-altitude upset training. They never have the chance to practice recovery maneuvers," Sullenberger adds.

Voss believes crews need to brief prevention, recognition and recovery from high-altitude upsets prior to flying into regions where such risks might be encountered.

Essential parts of a high-altitude upset training program should include a refresher of high-altitude aerodynamics and Mach effects, including the effects of altitude and Mach on stalling AoA. Simulators need to be programmed with a wider and higher range of aircraft aerodynamic and high-altitude meteorology characteristics so that pilots can learn to recognize signs of a high-altitude upset and rehearse recovery procedures.

Sullenberger bel ieves that highaltitude upset recovery training ought to be wrapped into comprehensive Line Oriented Flight Training (LOFT) scenarios in simulators. "Several years ago, LOFT was modeled on recent accidents and incidents that could reduce vulnerability to the same mishaps. Now there are strong economic pressures to cut back on LOFT," he said.

Introducing shock and surprise is an essential component of such training. "My argument is that human performance is a variable based on the particulars of the situation," says Robert "Key" Dismukes, Ph.D., NASA Ames' former chief scientist of its human factors research and technology division. "There are fairly large probability variables depending upon the situation." Dismukes and Lelaie, among others, believe that the "startle factor" blocks pilots' broad interpretation of all aspects of the situation.

Sullenberger agrees: "You have a mental picture and then everything goes crazy, especially during night IFR conditions. This makes it much harder to process what's going on. We do not process well in surprise and shock. It's hard to reason."

Such instantaneous information overload may have been contributing factors in the AF447 crash.

"All of this, including training, policies and procedures has to be part of an operator's organizational culture," Dismukes says. "If we just say the pilots screwed up, then we're not going to learn anything and we're not going to prevent future accidents."

Ultimately, the aviation industry will need to adjust to the high-altitude challenge by possibly requiring forward fit and retrofit of AoA indicators, more comprehensive ground training, highaltitude upset training in simulators and standard operating procedures that include crew briefs on high-altitude upset recovery procedures prior to flying through threat areas.

If the aviation industry eliminates highaltitude upset accidents, it would be a fitting tribute to the people who perished aboard Air France 447.

Reprinted with acknowledgement to Business & Commercial Aviation July 2011.

When safety stalls

From the routine, pre-landing announcement 'cabin crew, take your seats' to the impact with a damp Dutch field took just 19 chaotic seconds, during which autopilot disconnect and stick shaker sounds, and the ominous computer-generated phrases 'sink rate!' and 'pull up!' filled the flight deck. But Macarthur Job, looking at the Dutch Safety Board's report, finds the seeds for this crash had been sown much earlier.

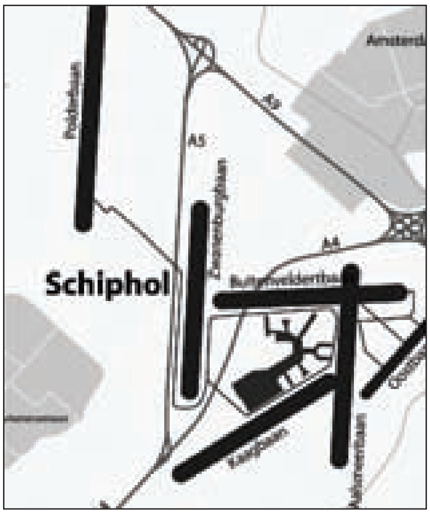
On 25 February 2009, a Turkish Airlines Boeing 737-800, operating a scheduled daytime flight from Istanbul to Amsterdam, crashed on its approach to Schiphol Airport. Four crew (including the three pilots) and five passengers were killed. Three other crew members and 117 passengers were injured. The wreckage came to rest 1.5 kilometres from the runway threshold.

The flight was a 'line flight under supervision', to give the first officer experience of the route, with the captain acting as his instructor and a second first officer on the flight deck as a safety pilot. There were also four cabin crew members and 128 passengers on board. The Schiphol weather at the time was overcast, with total cloud cover at 1000 to 2500ft, some heavy cloud at 800ft and lighter cloud at 700ft. Visibility was 4500 metres.

Investigation

Shortly after the accident, it was found that the Boeing's left radio altimeter had passed an erroneous reading of minus eight feet to the auto throttle system.

The Boeing 737-800 is fitted with two radio altimeter systems. In principle, the auto throttle uses altitude provided by the left-hand radio altimeter system, and only if an error is automatically detected in this system will the auto throttle use the right-hand radio altimeter system. The first officer was flying the aircraft from the right-hand seat, so his primary flight display showed the readings of the right radio altimeter, and after ATC provided the crew with the heading and altitude to be flown, the autopilot was selected to the 'altitude hold' mode.



Schipol runways

During the approach, the left radio altimeter displayed the incorrect height of minus eight feet on the captain's primary flight display but the first officer's primary flight display was indicating the correct height. Yet the lefthand radio altimeter system failed to record any error, so there was no transfer to the right-hand system. The erroneous reading thus continued to affect the various aircraft systems, including the auto throttle.

When the aircraft began following the glidepath, because of the incorrect altitude reading, the auto throttle moved into the 'retard flare' mode. This is normally only activated in the final phase of the landing below 27ft, but was now possible because other required landing conditions had been met, including selecting the flaps to the minimum landing setting of flaps 15. The thrust on both engines was accordingly reduced to 'flight idle', this mode being shown on the primary flight displays as 'RETARD'.

Meanwhile, with the right-hand autopilot receiving the correct altitude from the right-hand system, it was attempting to keep the aircraft on the glide path. As a result, the attitude of the aircraft continued to steepen to maintain lift as the airspeed reduced.

Initially, the pilots' only indication that the auto throttle would no longer maintain the selected approach speed of 144kt was the RETARD display. But when the speed fell below this at a height of 750ft, the fact would have been evident from the airspeed indicators on both the primary flight displays. And when the airspeed decayed to 126kt, the frame of the airspeed indicators would have changed in colour and begun flashing. The artificial horizons would also have shown the aircraft's nose attitude was becoming excessive. Yet the crew failed to respond to any of these indications.

Indeed, the loss of airspeed and steepening pitch remained unrecognised until the stick shaker stall warning went off at an altitude of 460ft. If the prescribed recovery procedure—selecting full engine power and lowering the nose—is implemented immediately this occurs, normal flight will be regained. Boeing's procedures also prescribe pushing the throttle levers fully forward.

The first officer did respond immediately to the stick shaker, pushing both the control column and the throttle levers forward. But the captain intervened, taking over control of the aircraft. The result was that the first officer's selection of thrust was interrupted, and with the auto throttle not yet disconnected, it immediately retarded the throttle levers again to 'flight idle'. Once the captain had full control, the auto throttle was disconnected, but still no thrust was selected. It was another nine seconds before the throttle levers were pushed fully forward. But it was too late—the aircraft had already stalled and its height of 350ft was insufficient for recovery.

Turkish Airlines TK1951 crash site

Non-stabilised approach

Up to the point when the stick shaker activated, the crew, somewhat under pressure because of the reduced visibility, were still carrying out their landing checks. But Turkish Airlines' standard operating procedures prescribe that, in reduced visibility, all these actions should be completed by the time the aircraft has descended to 1000ft. If the checks have not been completed by then, and the approach has not been stabilised, the crew should execute a go-around. This provision is not confined to Turkish Airlines, but is a general airline rule. Although the crew acknowledged passing through 1000ft, they did not initiate a go-around.

The crew also called passing through 500ft. A goaround is required at this altitude if the aircraft is not stabilised, in conditions of good visibility. Again, this did not result in a go-around, despite the fact that the landing checklist had not been completed and the approach was still not stabilised. The captain evidently did not regard continuing the approach below 1000ft, or even when the aircraft passed through 500ft, as a threat to a safe landing.

Interception of the ILS

The localiser signal of the instrument landing system is the first to be intercepted. Then, during a normal ILS interception, the glide path is intercepted from below. ATC however, had instructed the crew to maintain 2000ft. This resulted in the aircraft intercepting the localiser signal at 5.5nm from the runway threshold. But according to ATC procedures, for an aircraft at 2000ft, this should have occurred by 6.2nm to enable it to intercept the glide path from below. ATC's approach instruction, without also instructing the aircraft to descend, resulted in the glide path having to be intercepted from above.

When the thrust levers moved to 'flight idle' as a result of the auto throttle's 'retard flare' mode, the aircraft reacted as expected. But because the pilots were expecting the aircraft to descend to intercept the glide path, and to lose speed for the selection of flaps 15 and then flaps 40, this masked the fact that the auto throttle had moved into 'retard flare' mode. And when the airspeed fell below the final approach speed, followed by the increase in aircraft pitch and the flashing of the airspeed box, both pilots were busy with the landing checklist and its related actions.

The radio altimeter

The Dutch Safety Board's (DSB) investigation could not uncover a reason for the left radio altimeter system indicating incorrectly. A few days after Schiphol, the DSB warned Boeing of the circumstances of the accident, and Boeing, after consultation with the Board, immediately sent a notice to all Boeing 737 operators.

The problem is not an isolated one, and the failure of radio altimeter systems in Boeing 737 aircraft has a long history. It has happened not only to Turkish Airlines, but also to other airline companies. Turkish Airlines had been bringing the problem to Boeing's attention since 2001, as it had occurred at various times and in various ways over those years. Turkish Airlines had also sought all manner of technical solutions to reduce the likelihood of corrosion, cited as a possible cause of the poor performance of radio altimeter systems.

Given that the problem had also manifested itself in other airlines, the primary responsibility for solving it clearly lay with Boeing as the designer and manufacturer of the aircraft. Though Boeing receives around 13,000 reports each year regarding technical problems with the B737, comparatively few relate to the radio altimeter systems affecting the automatic flight system. And only in some cases did these concern activation of the auto throttle's 'retard flare' mode.

Although there were relatively few occurrences, the Dutch Safety Board believed Boeing should have had a greater appreciation of the problem—particularly its effect on the auto throttle—and its possible safety consequences. Analysis of the problems with the radio altimeter system (and its effects on the systems that used radio altimeter data) would therefore have been appropriate. It also would have been helpful to inform airlines of the problems and their possible implications.

The Board reached this conclusion for two reasons. A question from an airline company in 2004 about the flight crew operations manual led to the inclusion of a warning that, with a radio altimeter inoperative before the flight, the associated autopilot or auto throttle should not be used for approach and landing. Boeing was thus aware of possible inadequacies in the radio altimeter system. However, this did not result in any procedures for situations where problems with the radio altimeter system developed *during* flight.

Secondly, two incidents discussed in Boeing's Safety Review in 2004, in which the 'retard flare' mode was activated at 2100ft and 1200ft respectively, as a result of negative radio altimeter readings, also showed Boeing was aware of the possible consequences that followed in the Schiphol accident. Even so, after statistical analysis and flight simulator tests, Boeing concluded it was not a safety problem—pilots obtained adequate warnings and notifications in time for them to intervene, recover the situation and land safely. However, the Board believed that an additional warning to ensure pilots intervened in time would certainly not have been out of place.

Operating procedures

Standard operating procedures in aviation are safety barriers designed to ensure that flight safety is not compromised. An example is the Turkish Airlines procedure, that if the approach is not stabilised by 1000ft, no attempt should be made to land. Being stabilised early on an approach is important, not only to ensure the aircraft is in the correct configuration and power selection for landing, but also to provide pilots with a chance to comprehensively monitor every aspect of the final approach. As demonstrated by the chain of events during flight TK1951, the importance of these standard operating procedures cannot be underestimated.

Line flying under supervision

The first officer had joined Turkish Airlines several months before the accident, after serving in the Turkish Air Force, where he had gained some 4000 hours of flying experience. The accident flight was his seventeenth line flight under supervision, and his first to Schiphol Airport. Line flying under supervision is designed to familiarise a pilot with the operational aspects of airline flying, and on the first 20 such flights for Turkish Airlines, an additional pilot on the flight deck acts as an observer and safety pilot.

The captain acts as an instructor on this type of flight, meaning that he has instructional duties additional to his command responsibilities. With the captain under a greater operational load than usual, one of the functions of the safety pilot is to warn the crew if anything is overlooked. But in this case he did not do so when the airspeed fell below the selected value.

Possibly the safety pilot was also distracted. Shortly after the pilots selected flaps 40, the cabin crew informed him that they were ready for landing.

He passed this to the captain, and shortly before the stall warning activated, he was conveying the captain's advice of the impending landing back to the cabin. He did warn the captain of the exceedingly low airspeed when the stick shaker activated, but the Board believed the safety pilot system did not work as well as it should have done.

Approach-to-stall training

European pilot training requirements applying to Turkish Airlines only prescribe approach-to-stall training in the context of aircraft type qualification—the training required for crewing a particular aircraft type. The first officer had recently undergone his type qualification training, and this could explain his rapid reaction to the stick shaker.

There is no prescribed training for recovery-after-a stall-warning in any recurrent training syllabus. Apparently the thinking behind this is that approach to-stall situations are unlikely, and that pilots know how to deal with them. Furthermore, all communication and coordination procedures for monitoring flight path and airspeed are aimed precisely at avoiding such situations.

The Board concluded that the training requirements were inadequate. It noted that in some cases, such as for a captain, there were no provisions for practising or revising approach-to-stall situations, and this might apply for many years. But the fact that an approach-to stall warning is a last opportunity to recover control in an immediate and acute emergency means that it is crucial for the flight crew to be able to respond effectively. 'The Board accordingly considers that recurrent airline training should include approach-to-stall training,' the report concluded.

The various factors outlined in this accident review, and even a combination of some of them, will occur frequently in airline operations somewhere in the world. What was unique about this accident was the coincidence of all the factors at a critical stage of the aircraft's approach to land. These factors—the erroneous radio altimeter reading, its effect on the auto throttle system, the pilots' failure to notice the fall in airspeed and the aircraft's increasing pitch, and finally the safety pilot's failure to warn the crew of the developing situation—all reached their peak just before the onset of the stall warning. The result was that the aircraft's airspeed and attitude were not being closely monitored at the point when it was most necessary, and a tragedy resulted.

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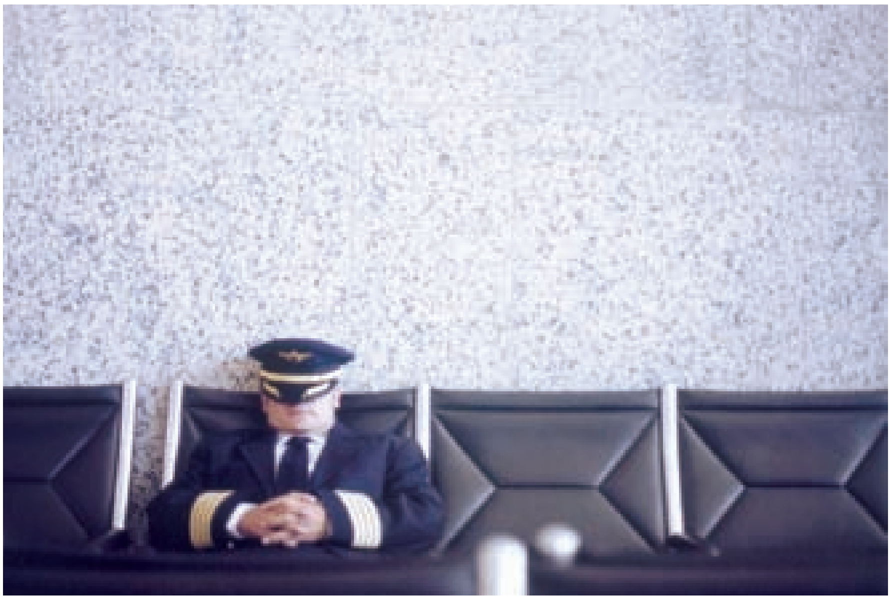
Easing Fatigue

by Tom Kok



Unfortunately, fatigue is everywhere and unavoidable in aviation. Pilots fatigue is a significant problem in modern aviation operations, largely because of the unpredictable work hours, long duty periods, circadian disruptions and insufficient sleep that are commonplace in civilian flight operations.

The full impact of fatigue is often under appreciated, but many of its harmful effects have long been known. Compared to people who are well-rested, people who are sleep deprived think and move more slowly, make more mistakes, and have memory difficulties. These negative effects may and do lead to aviation errors and accidents.

A position paper adopted by a panel of the Aerospace Medical Association (AsMA) said that accident statistics, pilot reports and operational flight studies all indicate that aviation operators are increasingly concerned about fatigue.

"Long haul pilots frequently attribute their fatigue to sleep deprivation and circadian disturbances associated with time zone transitions', the fatigue panel wrote. "Short haul (domestic) pilots most frequently blame their fatigue on sleep deprivation and high workload. Both long - and short haul pilots commonly associate their fatigue with night flights, jet lag, early wakeups, time pressure, multiple flight legs and consecutive duty periods without sufficient recovery breaks:'

Traditional approaches

Fatigue can negatively affect both physical and cognitive functioning as well as mood and thereby negatively impact a crew's response time, decision making and crew co-ordination. In order to minimize fatigue-related errors and accidents, regulators have traditionally imposed hours-of-service limits governing how long and how often pilots can operate an airplane. Different countries impose different limits, but they are usually based upon very little, if any, scientific knowledge concerned about fatigue. The Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA) regulations governing flight time limitations are no different.

They mostly lack a sound scientific basis and have remained essentially unchanged for the last fifty years. While these regulations have undoubtedly saved many lives, they are a fairly "blunt instrument" for managing the safety risk posed by fatigue. The traditional prescriptive HOS (Hours of Service) approach most likely derives from earlier regulatory models for managing physical rather than mental fatigue. Prescription of duty limitations may have been appropriate for physical fatigue, the same cannot be assumed for mental fatigue.

Accidents continue to occur in which fatigue is cited as a significant contributor. According to some sources, fatigue is a contributing factor in 15 to 20 percent of fatal aviation accidents associated with pilot error. While several unsuccessful attempts have been made to update the regulations, such efforts can best be described as "tweaking" what already exists and would likely result in little improvement. As an example, many regulatory regimes around the world do not recognise any difference between eight hours of duty time during the day and eight hours at night.

Three aspects of fatigue

Flight Surgeon Gregg Bendrick of the U.S. National Aeronautics and Space Administration (NASA) teaches that there are three aspects of fatigue: circadian rhythm, acute sleep loss and chronic sleep loss. Circadian rhythm means that people have "low points" in their day in terms of alertness and functionality. A mild low point is normally in the mid-to late afternoon, whereas the other, more significant major low point is in the early morning - when one normally is sleeping. Circadian rhythm physiology makes it easier for humans to *lengthen* their day rather than to *shorten* it.

Acute sleep loss refers to how many hours one has been continuously awake. The real problem comes in when the acute sleep loss overlaps the major low point in the circadian rhythm. At the point, performance deteriorates to the point of being identical to someone who is legally drunk.

Chronic sleep loss - the difference between the number of hours slept and the number of hours of sleep required - over the preceding two weeks lessens the effect of the usual countermeasures.

Towards Fatigue Risk Management

The shift away from the blunt instrument of only limiting hours of sleep has become known as fatigue risk management (FRM). FRM is fatigue management within the framework of a safety management system (SMS). According to Dawson & McCulloch of the University of South Australia Centre for Sleep Research, within an SMS framework, five levels should be considered in managing fatigue risk.

- Sleep opportunity or average sleep obtained across the organisation
- Actual sleep obtained by individual employees
- Presence of fatigue related behaviour
- Occurrence of fatigue related errors and
- Occurrence of fatigue related accident and/ or incident [figure 1]

In this context, a fatigue related incident (FRI) is merely the end point of a causal chain of events and is always preceded by a common sequence of event classification that lead to the actual incident, according to Dawson & McCulloch. Thus an FRI is always preceded by a fatigue related error (FRE).

A FRM system can be effective only if it addresses each of the five levels with organised defence systems.

For example, limits on a crewmember's hours of service would be - according to figure 1 - a Level 1 defence designed as an attempt to ensure that the crewmember had an opportunity for sufficient sleep. If the crewmember did not receive adequate sleep, the error trajectory would continue beyond Level 1. A system with little or no hazard controls at Level 2 or beyond may be quite poorly defended against FREs.

Defenses-in-Depth Approach to Managing Fatigue

Hazard Assesment	Error Trajectory	Control Mechanism
Sleep opportunity/ Average sleep obtained	Level 1	Prescriptive hours of service Aggregate prior sleep-wake model Fatigue modeling
Actual sleep obtained	Level 2	Prior sleep and wake data
Behavioral symptoms	Level 3	Symtom checklist Self-repot behavioral scales Physiological monitoring
Fatigue-related errors	Level 4	Fatigue proofing strategies SMS error analysis system
Fatigue-related incidents		SMS incidents analysis systems
	Level 5 Actual incident	

Degraded crew performance

A reduction in sleep during the 24-hours preceding flight is the fatigue -related variable most consistently associated with changes in crew performance, Dawson & McCulloch said. "Crews take longer to make decisions if they have obtained a small opportunity to sleep (based on recent duty, history), have obtained a small amount of sleep in the prior 24 hours or are experiencing high levels of subjective fatigue" according to Dawson & McCulloch. Taking longer to make decisions may have negative implications, for operational safety, as this could lead to greater time pressures, which may enhance the risk of errors during the later stage of flight, The study also found several areas such as improved cross - checking, in which fatigue was associated with improved performance, perhaps because fatigued crews anticipated errors and "devoted more cognitive resources and targeted behavioural strategies towards the detection of fatigue-related error:" Cognitive refers to the ability of a person to process information, apply knowledge and change preferences.

In flight strategies

In a 1999 NASA survey 80 percent of 1424 flight crewmembers from regional airlines said they had nodded off during a flight. The AsMA fatigue panel reviewed several in-flight fatigue counter measures including napping on the flight deck, activity breaks, bunk sleep on long-haul flights and in-flight rostering.

According to the panel, in-seat napping of up to 40 or 45 minutes is a safe and effective risk management tool that could "significantly improve alertness... and help sustain aircrew performance during situations in which unexpected delays require the postponement of the next consolidates sleep opportunity.

Research has also found that alertness is improved with breaks for mild physical activity and increased social interaction "or even just temporary disengagement from: monotonous tasks with the AsMA panel recommending breaks of about 10 minutes each hour.

Tactical caffeine use

Crewmembers should also understand how their intake of caffeine – in coffee, tea, soft drinks and some pain relievers – will affect their alertness. "Numerous studies have shown that caffeine increases vigilance and improves performance in sleep deprived individuals, especially those who, do not consume high doses" the AsMA panel said, "Caffeine... is already used as an alertness – enhancing substance in a variety of civil and military flight operations and it has proven safe and effective."

Most people feel the effects of caffeine – including increased alertness, decreased sleepiness and a more rapid heartbeat within 15 to 20 minutes, and these effects typically last four or five-hours, longer in people who are especially sensitive. Crewmembers who use caffeine for alertness should consume it in small quantities, "and save the arousal effect until they really need it" the panel said. "This is called 'tactical' caffeine use:" The panel recommended that crewmembers avoid taking more than 1.000mg of caffeine in any 24-hour period, take it only "when it is truly needed to reduce the impact of fatigue" and avoid it within four hours of bedtime.

Caffeine content of common drinks

Drink	Average quantity mls	Per Average quantity mg	Mg per 100mls
Coffee (Espresso)	44	77	173.6
Coffee (Brewed)	236	108	45
Red Bull	250	80	32.0
Tea (Brewed)	236	47	19.9
Coca-Cola Classic	354	35	9.7
Tea (white)	236	15	6.3

Fatigued in the back & in maintenance

In the last few years, the aviation industry has also begun to study flight attendant fatigue. Recent and planned flight attendant fatigue studies include participants completing sleep diaries to verify sleep/wake schedules. In reports around the world, flight attendants have admitted that due to fatigue they had forgotten to arm their evacuation slides or had forgotten they had unaccompanied minors onboard and allowed them to leave the aircraft by themselves. In some instances, flight attendants have reported being stopped by the police when driving due to the fact that police believed they were driving under the influence of alcohol because of their erratic driving. Just prior to that they would have, by the regulator's account, been okay to operate the emergency equipment onboard an aircraft in a fatigued fashion. However, as a fatigued driver on the road they are a hazard to others.

Flight attendants still have to jump through hoops to say "I'm fatigued to their airline without disciplinary consequences;" said Candace Kolander during the February 2009 Cabin Safety Symposium of the Southern California Safety Institute. It is important to allow flight attendants to call in fatigued without discipline but also recognise and mitigate the problem by providing fatigue training in recurrent training.

If airlines want to have a complete SMS, they can't just look at fatigue in the front of the airplane, they need to look at fatigue in the back as well as amongst maintenance personnel.

No 'One-Size-Fits-All' Cure

Crewmembers should be educated about proper sleep hygiene. Ultimately, the individual pilot, scheduler and management must be convinced that sleep and circadian rhythms are important and that quality day-today sleep is the best possible protection against on-the-job fatigue according to the AsMA panel. Educational efforts should emphasize five points, the panel said:

- Fatigue is a physiological problem that cannot be overcome by motivation, training or willpower:
- People cannot reliably self-judge their own level of fatigue-related impairment;
- There are wide individual differences in fatigue susceptibility that must be taken into account but which presently cannot be reliably predicted;
- There is no one-size-fits-all 'magic bullet' (other than adequate sleep) that can counter fatigue for every person in every situation; but
- There are valid counter-fatigue strategies that will enhance safety and productivity, but only when they are correctly applied.

Fatigue represents a significant risk in aviation when left unaddressed. This article provides a number of strategies and that can be employed to increase safety by reducing the risk of fatigue.

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Strategies for better sleep

Recommendations to optimize sleep opportunities

- Wake up and go to bed about the same time every day.
- Use the sleep area only for sleep – not for everyday jobs.
- Establish a consistent bedtime routine – for example, read and take a hot shower, then go to bed.
- Perform aerobic exercises every day but not within two hours of bedtime.
- Keep the sleep area dark, quiet, comfortable and relatively cool.
- Move the alarm clock out of sight.
- Avoid caffeine in the afternoon and evening.
- Avoid using alcohol to promote sleep.
- Avoid cigarettes, especially before bedtime.
- If you can't sleep, leave the sleep area and do something relaxing. When you become sleepy, go back to bed.

Recommendations for rotating shift schedules

- When rotating onto night duty, avoid morning sunlight.
- To promote daytime sleep, keep the sleep area dark and cool; use eye masks and either earplugs or a "masking noise" to limit interference from light and noise.
- Comply with the "recommendations to optimize sleep opportunities" above, with adjustments for daytime sleep. Before night duty, take a short nap.
- After waking from daytime sleep, expose yourself to at least two hours of sunlight or artificial bright light in the late afternoon or early evening.

Notes:

Caldwell JA, Mallis MM, Caldwell JL, Paul MA, Miller JC, Neri DF, AsMA Aerospace Fatigue Countermeasures Subcommittee of the Human Factors Committee. *Fatigue counter measures in aviation*. Aviation, Space and Environmental Medicine, Volume 80 (January 2009): 29-59

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This article is based on the following Flight Safety Foundation Publications

Werfelman, Linda. "If you don't snooze, you lose" Aviation Safety World, Volume 1 (November 2006): 13 - 17 http://flightsafety.org/asw/nov06_p13-17.pdf

Werfelman, Linda. "Easing fatigue" Aviation Safety World, Volume 4 (March 2009): 22 - 27 http://flightsafety.org/asw/mar09_p19-21.pdf

Anthony, Thomas. "Wake me when my shift is over" Aviation Safety World, Volume 4 (March 2009): 19-21 http://flightsafety.org/asw/mar09/asw_mar09_p19-21.pdf

Rosenkrans, Wayne. "Fatigued in the back", Aviation Safety World, Volume 4 (June 2009): 34-37 http://flightsafety.org/asw/jun09/asw_jun09_p34-37.pdf

These articles can be downloaded in full for free from the internet addresses stated under each article.

Dangerous Goods – The hidden risks to commercial aviation

by Geoff Leach, Manager of Dangerous Goods office at UK Civil Aviation Authority

11 May 1996. After a delay caused by a mechanical problem Valujet flight 592, a Douglas DC-9-32 with 105 passengers and five crew onboard pushes back from the gate at Miami International Airport for departure to Atlanta.

Twenty minutes later, after taxiing to runway 9 Left, the aircraft is airborne but after only six minutes the flight crew receive indications of significant electrical malfunctions. Shortly after, screams from the cabin of "fire" are recorded on the cockpit voice recorder, with a flight attendant heard to say that the cabin was "completely on fire". Three minutes after the first indication of a problem the aircraft crashes into the Everglades. There are no survivors.

The cause of the accident was the improper carriage in the cargo hold of chemical oxygen generators, the devices fitted in the passenger cabin to provide oxygen in the event of a depressurisation. Pulling an oxygen mask to the face causes a candle of sodium chlorate in the generator to ignite, resulting in the production of oxygen. However, as a consequence, the generator gets extremely hot (in excess of 280°C and whilst this does not pose a danger when fitted to the aircraft the temperature is such that any combustible material, such as packaging, which comes into contact with the generator can ignite, the flame then being fed by the oxygen the generator is designed to produce.

Chemical oxygen generators are just one example of items which meet the criteria of dangerous goods. Such goods are routinely and regularly carried on both passenger and freighter aircraft as cargo and comply with a set of requirements produced by ICAO, known as the 'Technical Instructions', ensures that no danger is posed to the aircraft or its occupants. The Valujet accident was a stark illustration of how dangerous goods can cause a catastrophe if they are not prepared for transport in accordance with the Technical Instructions. This was not the first fatal accident to be caused by dangerous goods. In 1973, the three-crew members of a Pan Am Boeing 707 freighter were killed when the aircraft crashed following an in-flight fire caused by an improperly prepared consignment of nitric acid.

Dangerous goods fall within one of nine classes:

Class 1: Explosives (e.g. ammunition flares)
Class 2: Gases (e.g. oxygen, propane)
Class 3: Flammable liquids (e.g. paint, adhesives)
Class 4: Flammable solids and reactive substances (e.g. matches, magnesium)
Class 5: Oxidizers and organic peroxides (e.g. chemical oxygen generators, resin kits)
Class 6: Toxic and infectious substances (e.g. cyanide, infected blood)
Class 7: Radioactive substances (e.g. radio-pharmaceuticals)
Class 8: Corrosives (e.g. wet batteries, mercury)
Class 9: Miscellaneous (e.g. vehicles, lithium batteries)

The transport of dangerous goods by air in cargo is not only very important for international commerce, but also for other reasons such as public health. This is particularly relevant to radioactive material, much of which is shipped for the treatment or diagnosis of disease. Failure of radioactive material to travel as booked can and has caused potentially life saving surgical procedures to be cancelled.

The dangers posed by passengers

It is not only dangerous goods in cargo which can pose a danger to flight safety. Over the years passengers have carried numerous items which have had the potential to cause a catastrophe, such as petrol fuelled chainsaws, fireworks and even phosphorus grenades. Generally, passengers are not allowed to carry dangerous goods as part of their baggage, although there are a few exceptions; items which may be carried (subject to quantity limitations) include toiletry or medicinal items (including aerosols), alcoholic beverages and lithium batteries such as those used to power lap top computers, mobile phones, etc.

Notices warning passengers of dangerous goods which are forbidden from carriage on board an aircraft, must be prominently displayed

There are nine classes of dangerous goods, radioactive material is just one.

The education of passengers in this respect is very difficult, a task made no easier by the understandable priority given to security since the terrorist attacks of 9/11. Since that time much emphasis has been placed on the need for 'sharps' and other items restricted for security reasons to be placed in checked (hold) baggage. But dangerous goods generally pose the same danger to aircraft wherever they are carried and so most are not permitted at all.

Experience has shown that it is very difficult to convey to passengers the difference between dangerous goods and items restricted for reasons of security, with many still failing to appreciate that not everything can be packed in the hold. Indeed, there are dangerous goods which are only permitted if they are carried in the cabin and nowhere else, the most notable of these being safety matches and lighters - passengers may carry a small packet of safety matches or a single lighter provided they are carried on the person e.g. in a pocket. This is so that if these items were to ignite during flight this would be readily apparent (not least to the passenger) and cabin crew would be on hand to deal with the incident. The same would not be so in the hold of an aircraft where the onboard fire detection and suppression systems would have to be relied on. Fires in baggage caused by lighters and matches are not uncommon, with over 50 being recorded over a 25 year period in the United Kingdom alone.

Another important aspect relating to passengers, and one which may involve airport operators, is the carriage of battery powered wheelchairs. In 2008 at Manchester Airport, ground staff unloading baggage from the forward hold of a Boeing 757 noticed blue sparks coming from such a wheelchair. The chair was removed from the aircraft and placed on a vehicle, where it immediately burst into flames and was destroyed. The cause of the fire could not be determined, although investigations revealed a misunderstanding in the industry about how battery powered wheelchairs must be prepared for transport. The ICAO Technical Instructions require the batteries on such wheelchairs to be protected against short circuit but this was being misinterpreted as a need to disconnect the battery, which is not necessarily required, and if not done properly can in fact increase the risk of fire. Further details can be found at www.CAA.co.uk/fodcom4508.

The role airport operators can play

When the requirements of the ICAO Technical Instructions are adhered to the transport of

The correct packing and handling of dangerous goods within the cargo hold is essential

dangerous goods by air is a very safe activity and there are a number of ways that airport operators can contribute to ensuring these remains so:

In Cargo

As required by Annex 14 to the Chicago Convention ('Aerodromes'), the aerodrome emergency plan must provide for the coordination of the actions to be taken in an emergency (such as a dangerous goods occurrence) at an aerodrome or in its vicinity. An essential element of this is that procedures are in place to ensure that details of any dangerous goods onboard an aircraft involved in an emergency, which have either been transmitted to the airport via Air Traffic Control or are held by the operator or his agent at the airport are passed to the Rescue and Fire Fighting Services as soon as possible.

In passenger baggage

Notices warning passengers of dangerous goods which are forbidden from carriage on board an aircraft, must be prominently displayed, in sufficient number, at each of the places at an airport where tickets are issued, passengers are checked in and aircraft boarding areas are maintained, and at any other location where passengers are checked-in. ICAO places this requirement on both the airline and the airport operator and it is essential that neither is impeded in this duty (there have been occasions when an airline has been prevented from displaying notices by the airport operator).

Fires in baggage caused by lighters and matches are not uncommon

Alternative methods of advising passengers of forbidden dangerous goods can be employed e.g. display cabinets containing examples of forbidden dangerous goods, advisory videos which can be played at various locations at the airport (e.g. while passengers are waiting to be security screened), airport web sites which can contain details of what a passenger may or may not carry.

It is important that airport security staff are appropriately trained in dangerous goods, not so that they actively search for such items but so they recognize forbidden dangerous goods when they come across them.

International standards exist to ensure potentially dangerous items are carried correctly on board aircraft. Any breach of the regulations, whether intentional or accidental, can cause major disruption at busy airports and endanger passengers and staff both on the ground and in the air. Everyone in commercial aviation should be aware of what is and is not allowed for carriage on an aircraft and enforce those rules vigorously.

Geoff Leach is Manager of Dangerous Goods Office at United Kingdom Civil Aviation Authority. He currently chairs the ICAO Dangerous Goods panel and the Dangerous Goods European Liaison Group.

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Driving Safety Forward

by Tony Heap, Strategy & Standards officer in the Areodrome Standards Dept, UK Civil Aviation Authority (CAA)

Working airside has never been short of hazards. Airport operators and regulators have long concentrated safety planning on protecting those individuals working on ramps, aprons, taxiways and runways. Unfortunately, ground handling incidents continue to rise worldwide, resulting in injuries to personnel and damage to aircraft and property. Additionally, the use, and indeed, misuse of vehicles in airside areas has led to major operational disruption at busy airports.

As part of our on-going strategy to improve airside safety, the UK Civil Aviation Authority (CAA) has introduced a brand new Airside Driving Permit scheme. The development of the scheme has led to a unique working partnership between the CAA and Industry. The working group tasked with developing the scheme, although guided by the CAA, has drawn its membership from a variety of Airport Operators Association (AOA) member aerodromes.

The CAA first produced a formal Safety Plan in 2004, which included a focus on ramp safety. In 2006, the Safety Planning process was substantially changed when it employed both a 'bottom up' model, using the considerable expertise in the organisation to identify potential risks, and a new 'top down' process, starting with the major risks identified by available data, such as Mandatory Occurrence Reports. An initial working group, including representatives from BAA and AOA, was subsequently set up to analyse the root causes of incidents that occur on the apron. This group recommended a series of actions aimed at reducing the risks to aircraft and their occupants while on the apron area. A larger CAA/industry working group was then established to formulate an action plan to push forward further improvements. The Ground Handling Operations Safety Team (GHOST) was created and met for the first time in December 2007. One of its first recommendations was for a new national airside driving permit scheme to replace the existing AOA system.

Current AOA permits are issued according to the applicant meeting two criteria; medical standards and competency standards. Medical standards are self explanatory, although it should be noted the physical requirements are far above those needed to drive the equivalent vehicle on the roads. Competency standards are currently catered for in the multi-choice test questionnaire presented at the end of the training course.

Working airside has never been short of hazards and the UK CAA recognises the need to improve on airside driving standards

With airside driving identified as a major contributor to hazards on the apron, the GHOST team established that changes to the current airside driver training requirements were necessary. Particularly, as existing CAA guidance, although comprehensive, lacks clarity on the rules governing the training, issuing of driving permits and medical standards required to obtain an Airside Driving Permit.

The three big differences between the existing AOA scheme and the proposed new scheme are medical requirements, aerodrome area covered by the national permit scheme and maintenance of competency. In the past 10 years, records show that few accidents have been attributed to a medical condition; most are caused by lack of appreciation/ understanding of the environment they are working in. This falls mainly into the competency side of the equation.

The results of work related to Human Factors have indicated that standardisation may be the key that helps driver awareness and provides the clues to help avoid driver errors. Therefore, standard markings and practices, including Radio Transmissions (RT), are being promoted as mitigation. In the manoeuvring area, we believe this should be addressed by compliance with Annex 14, CAP 168 and CAP 413.

As mentioned before, Airside Driving was one of those activities identified as a root cause of incidents and accidents on the apron. Driving on the airside of an airport in close proximity to aircraft and within the areas of intense activity, usually in a restricted space, requires a level of competence gained through good training, experience and regular testing supported by a safety management system that allows the aerodrome operator to monitor the standard of airside driving activities. The new scheme is designed to reduce the amount of vehicle related accidents on the apron by increasing the competency requirements and reversing the growing trend in vehicle related runway incursions by restricting the access to the runway to only those essential drivers needing access during operational hours.

The working group investigated the proposal to introduce the concept of aligning the Permit Scheme with the GoSkills initiative. GoSkills is the Sector Skills Council (SSC) for passenger transport. Licensed by the UK Government, their mission is to work with employers UK-wide to improve the skills that make a difference to the performance of the passenger transport sector. The training will be based on the principals of the National Occupational Standards (NOS) for Aviation Operations on the Ground. Following a successful training course, the applicant will receive a nationally recognised qualification.

The incentive in choosing this route was to emphasise the point that anyone holding the new Airside Driving Permit will be regarded as a professional driver with the competencies and attitude the status endorses. Further work in this area however has highlighted the need to separate the airside driving scheme from the NOS until such time that the NOS for aviation are developed further.

Airport operators and regulators have long concentrated safety planning on protecting those individuals working on ramps, aprons, taxiways and runways

We are pleased that the first edition of CAP 790 Requirement for an Airside Driving Permit Scheme was published on 29 February 2012. The document provides national guidance on airside vehicle operations and driver permits and recommends standards to be set by aerodrome authorities. It includes material on driver training, qualifications, medical requirement/fitness to drive and maintenance of competency on vehicle standards.

All airside users are responsible for maintaining airside safety; in the UK the Health & Safety Executive is actively working with the CAA to combat the increasing numbers of accidents and incidents on the apron and runway incursions by vehicles.

The objective of the guidance is to assist aerodrome authorities in establishing a regime where staff who are required to operate vehicles and equipment airside are properly trained to do so in a safe manner with the full knowledge of the relevant rules, procedures and instructions and an awareness of the consequences of contravening them. Guidance is also provided for employers regarding the provision and safe use of vehicles and equipment.

Depending upon the scale and complexity of the aerodrome and the individual requirements of the driver, the guidance material will take into account the following main areas:

- A generic airside driver training programme which covers operational safety and health and safety aspects of operating vehicles, plant and equipment in close proximity to aircraft on aprons, stands and airside roads.
- Where the specific job function requires the driver to operate on the manoeuvring area, additional training on the hazards associated with runways and taxiways should be covered.
- An essential requirement of operating a vehicle on the manoeuvring area is the need to use VHF radio communications with Air Traffic Control, which will require training in the correct use of RT and standard phraseology.

The aerodrome authority should establish a system for the issue of ADP for drivers. The system should ensure that a permit is not issued unless the individual meets the minimum standards expressed in CAP 790 and there is confidence that the minimum standards will continue to be achieved through refresher training, competence monitoring and audit arrangements.

The airside driving permit scheme covers three specific areas of the airfield. The areas have been identified separately in recognition of the increased level of competency required to safely operate on the manoeuvring area and to design the training framework accordingly.

The initial permit awarded to a new driver who has successfully completed the training course will be the 'A' permit. The 'A' permit allows access to the Aprons, Stands and Airside Roads, which may include controlled and uncontrolled taxiway crossings. The awarding of the 'A' permit allows the holder to continue their training to operate on the manoeuvring area.

The 'M' permit allows access to the manoeuvring area excluding the runway. It is a pre-requisite for training for this permit that the candidate has successfully completed a Radiotelephony course. The holder of the 'M' permit will have attained a higher level of competence during driving training and will be encouraged to maintain competency through a structured maintenance of competency procedure.

The 'R' permit allows access to the runway during operational hours. Exposure to greater risk encountered when operating on the runway requires the driver to demonstrate the highest degree of competence. Therefore, the permit is valid for a short duration (one year) and the driver is required to maintain competency throughout the year and may be subject to audits during the period.

To enable aerodrome operators to establish and maintain a robust airside driver permit scheme, additional guidance contained within the CAP relates to language proficiency, maintenance of competency and structured training programmes. The CAP contains examples of best practice currently used by industry that may help aerodrome operators to manage the scheme. For example, reference is made in the structured training programmes to the use of technology for the delivery of training and assessment of the candidates. The working group believes the use of this new technology provides the key to a robust training and assessment programme as well as providing an engaging and interactive training session for the participants.

We are confident that this initiative will make a significant contribution to reducing incidents and accidents on the apron and a safer working environment for many years to come, and illustrates the CAA's commitment to maintaining the UK's world class aviation safety record.

Tony Heap is a Strategy and Standards Officer in the Aerodrome Standards Department at the UK CAA. He is currently on secondment to EASA to help the Rulemaking Directorate develop the new rules applicable to Aero dromes from 2013. Prior to joining the CAA, he was with BAA for 30 years mainly in an operations management role. He is also the Rapporteur for the ICAO PANS-Aerodrome Study Group.

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