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focus

ON COMMERCIAL AVIATION SAFETY

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Contents

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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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Front Cover Picture: Virgin Atlantic aircraft 'Beauty Queen' landing at sunset. Beauty Queen was the first of 10 A330 aircraft to join Virgin Atlantic's fleet.

Aviation and the Law

by Dai Whittingham, Chief Executive UKFSC

Aviation safety in the UK took a significant step forwards with two judgements handed down by the High Court in September. The first case related to the tragic Hunter accident at the Shoreham Air Show last year in which 11 people lost their lives. As part of the separate police investigation into the accident, the Chief Constable of Sussex Police had made an application to the High Court for disclosure of materials obtained during the AAIB investigation; this was the first such application made in England and Wales since the relevant aircraft accident investigation regulations came into force in 1996. The Court was effectively being asked to conduct a balancing exercise to determine whether the public interest in release of all the material requested as part of the police investigation was greater than the negative impact on future safety investigations.

The Judges refused disclosure of all the requested material, excepting the camera footage from the cockpit which had been intended for broadcast and could not therefore be considered as protected safety information. The legal argument set out in the judgement was founded on the ICAO Annex 13 provisions, the relevant EU regulations and the supporting UK laws on civil aviation and the investigation of accidents.[1]

The crucial part of the judgement concerned the requested release of witness statements, the Judge laying out his reasoning as follows:

"In my view it is almost inconceivable that statements made to the AAIB could properly be the subject of an order for disclosure when the appropriate balancing exercise is done by this Court. This is for two main reasons.

First, there would be a serious and obvious "chilling effect" which would tend to deter people from answering questions by the AAIB with the candour which is necessary when accidents of this sort have to be investigated by it. This would seriously hamper future accident investigations and the protection of public safety by the learning of lessons which may help to prevent similar accidents. As is clear from the text cited earlier from Annex 13 to the Chicago Convention, the EU Regulation and the 1996 Regulations, this would be contrary to one of the fundamental purposes of the regime in this area, which is carefully designed to encourage candour in the investigation of air accidents in order to learn lessons and prevent accidents in the future.

Secondly, it would be unfair to require such disclosure. This is because the powers of the AAIB, unlike the ordinary police, are such as to permit the compulsion of answers to questions: see Regulation 9 of the 1996 Regulations. Further, so far as I could discern from the hearing before this Court, there is no clear practice, to say the least, of giving a caution to the person interviewed. This is hardly surprising, since the purpose of such an interview is to obtain the fullest possible information in an accident investigation. This contrasts markedly with the purpose of a police interview, which is to elicit evidence which may be capable of being used at a subsequent criminal trial."

We should note that the judgement does not prevent a criminal prosecution for (e.g.) negligent acts leading to an accident, but it reinforces the position that safety information is protected by law unless (in the UK) the High Court determines that the balancing test over competing public interests is met in favour of disclosure.

In the second case, the Senior Coroner for Norfolk had required the AAIB's Chief Inspector of Air Accidents to disclose the CVR/FDR and/or a full transcript relating to an AW139 accident that occurred in the county in March 2014. The Chief Inspector refused to comply, submitting that the Coroner did not have the powers to make such an order; the Coroner fined him twice for non-compliance.

The High Court in its subsequent judicial review[2] quashed both the disclosure order and the fines, as the disclosure would breach an obligation under EU law unless ordered by the High Court itself following application of the balancing test. The Lord Chief Justice went further, pointing out the tendency of Coroners to conduct their own investigations into accidents rather than rely on the conclusions of the body with the greatest expertise in the matter. In his own comments, he stated:

"In the absence of credible evidence that the investigation into an accident is incomplete, flawed or deficient, a Coroner conducting an inquest into a death which occurred in an aircraft accident, should not consider it necessary to investigate again the matters covered or to be covered by the independent investigation of the AAIB. [...] [T]he findings and conclusions should not be reopened."

We now have some important case law on the books. First, the Shoreham judgement means that witness statements given for the purposes of safety investigations are protected in law and that the AAIB cannot be compelled to disclose them. A police officer wishing to have a witness statement must therefore conduct a separate interview and, crucially when prosecutions might be considered, such an interview must afford the witness the same protections as he or she would have for any other suspected crime.

We also have some protection from potentially non-expert investigations conducted by Coroners, who may not now effectively re-open AAIB investigations unless there is "credible evidence that the investigation is incomplete, flawed or deficient". Whilst AAIB inspectors may still in future be required to provide some supplementary information to a Coroner, they are unlikely to be subjected to cross-examination or be forced into expressing opinions that could be seen to allocate blame and which are subsequently used to support criminal or civil proceedings. Further, Coroners will not be able to demand access and hence expose CVR/FDR data that has not already been published by the AAIB.

However, we should not lose sight of the fact that CVR/FDR data (as distinct from witness statements) can still be released for criminal investigation purposes if the High Court determines that the public interest balancing test is met. The same is true of our own Just Culture system, which does not protect the individual from the consequences of deliberate or reckless acts; the balancing test here is conducted at the organisational level rather than in the courts.

Apart from discussion of Annex 13 as the background to our safety legislation, the Judges also drew on Regulation (EU) No. 996/2010, on the investigation and prevention of accidents and incidents in civil aviation. This has since been amended by Regulation (EU) No. 376/2014, but the amendment provides further strengthening of protections for safety information. And here, Brexit looms large. Brexit should have no impact on our other Treaty obligations in the form of the Chicago Convention, but the EC Directive laying down safety principles (later amended by 996/2010 and 376/2014) was given effect in the UK by the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996.[3] The protections we rely on are contained in Article 18 should you wish to consult it. It would be ironic indeed if the protection of safety information enshrined in these latest judgements were to become one of the unintended casualties of Brexit negotiations.

As for Brexit itself, informal discussions suggest the CAA favours remaining plugged firmly into EASA, although this is clearly a decision for the Government to take as part of its post-Article 50 negotiations. The timescale for bespoke UK legislation would be in the order of 5 years or so; complexity aside, drafting would need to take its place in the queue of all the other post-Europe laws. We cannot have aviation in this country being effectively un-regulated, and it will take considerable time, effort and expense for the CAA to regenerate a stand-alone capability that has not existed since the move to JAR-OPS. This implies some form of "lift and shift" approach to avoid a difficult and possibly dangerous interregnum, whatever the long-term solution turns out to be.

The additional pressure on the regulator comes at a time when performance-based regulation (PBR) is in its infancy and when all eyes should be on the task of making sure it works. In her keynote address to the recent conference of the International Society of Air Safety Investigators, Kathy Fox, Chair of the Transportation Safety Board of Canada (TSB), examined the organisational factors that contribute to accidents and the regulatory environment in which those organisations operate.

She noted that the Canadian regulator has moved to a systems-level approach whereby, in addition to verifying a company's compliance with regulations, its internal processes are examined to verify that there is also an effective system in place to proactively manage the risks associated with its operations. (Or, as we would call it here, PBR.) She also observed that this theory, and the move away from the traditional inspect-and-fix approach, only works if all companies have:

a) the ability to proactively identify safety deficiencies,
b) the capability to rectify them, and
c) a top-down, organisation-wide commitment to doing so.

Ms Fox then posed a series of questions: should the regulator wait for an accident before stepping in; should it wait for operators to fix the problems that have been identified, or should it adopt a firm hand before then? If so, at what point? Most telling was her observation that organisational factors and regulatory oversight were appearing in TSB's work ever more frequently as connected links in the accident chain.

While UK operators hold their own risks in the new PBR environment, will our own regulator be able to deploy sufficient resources on oversight tasks to guarantee intervention before an operator risk becomes a public risk? If Brexit does indeed end with the UK going it alone, and during the transition to whatever comes next, those regulatory resources are likely to be severely stretched. And when resources are stretched, it would be easy to slip from 'oversight' in its supervisory meaning, to 'oversight' becoming a sin of omission.

[1] *http://www.bailii.org/ew/cases/EWHC/QB/2016/2280.html*

[2] *http://www.bailii.org/ew/cases/EWHC/Admin/2016/2279.html*

[3] *http://www.legislation.gov.uk/uksi/1996/2798/made*

focus ON COMMERCIAL AVIATION SAFETY

How has our aviation world changed post 9/11?

by Jacky Mills, Chairman UKFSC

Ask anyone where they were and what they were doing on 11th September 2001 and I am pretty sure they will be able to tell you. That day changed forever so many aspects of aviation. That day the previously unthinkable happened: commercial passenger aircraft were used as weapons. The story is, sadly, well known. Four US passenger aircraft were highjacked by 19 terrorists. Two aircraft targeted and crashed into the World Trade Center buildings in New York City; these buildings both collapsed soon afterwards. A third aircraft was crashed into the Pentagon building south of Washington DC. The fourth aircraft crashed in a field in Pennsylvania following an onboard struggle between passengers and the highjackers. Just fewer than 3,000 people in total died in these atrocities, including passengers, airline crew, office workers and emergency services.

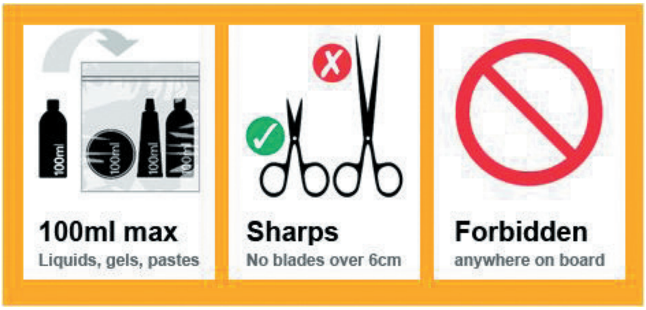
In the immediate aftermath the FAA ordered all civil aircraft to land at the nearest airport as soon as possible. 4,546 flights were airborne at the time of the order. A NOTAM was issued closing operations at all airports and an Advisory issued suspending operations in the US National Airspace System. Tremendous credit goes to all our colleagues in Swanwick who had to deal with a phenomenal number of 180 degree turns of UK aircraft over the North Atlantic. The following day the FAA allowed limited reopening of US commercial airspace to allow flights which had diverted on 11th September to proceed to their destinations, including international flights bound for the US and diverted to Canada.

From that day onwards new security measures had to be implemented which are now daily business for all airports, airlines and passengers. In that week all US airports had to implement new measures including search and security check of all airplanes and airports before passenger re-entry, a ban on curb side and off-airport check-in, access to boarding areas for ticketed passengers only, increased monitoring of vehicles near airports and a strict ban on knives and cutting tools as carry-on items.

What is not so well known is that within a week of the atrocities, aviation employee layoffs totalled 44,000 and Boeing announced it would lay off up to 30,000 workers. I remember an airline in the North East of the UK which was put into Administration, and subsequently ceased trading, that following week. Within a month worldwide airline layoffs totalled 128,000 employees.

On 12th November 2001 an American Airlines Airbus A300 crashed immediately after take off into Queens borough of New York City stirring fears of another terrorist attack. The accident, which killed 260 people on board as well as five on the ground, was subsequently found to have been caused by human error involving overuse of the rudder leading to mechanical failure. The aircraft had flown into the wake turbulence from an aircraft that had departed minutes before from the same runway.

In August 2006 the UK authorities uncovered a terrorist plot to detonate liquid explosives, disguised as soft drinks carried on board. This involved 10 commercial aircraft flying from the UK to the US and Canada. US Transportation Security Administration (TSA) banned all liquids, gels and aerosols from passenger carry-on baggage and subsequently mandated passengers remove shoes for inspection at security. In the UK all cabin baggage was restricted and had to the placed in the aircraft's cargo hold. This was subsequently followed by allowing passengers to carry on board aircraft only liquids, gels and aerosols 100ml or less in a clear, resealable plastic bag.



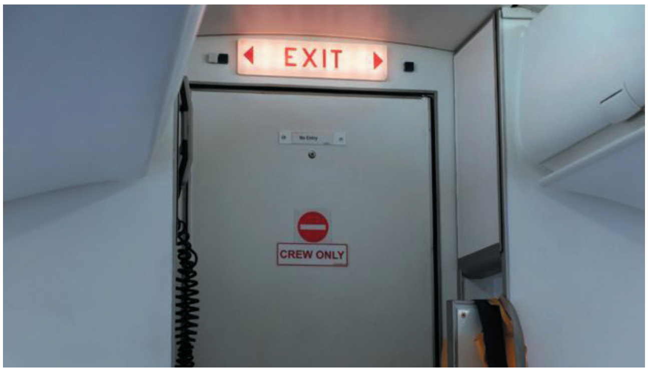
The subsequent opening in November 2014 of the One World Trade Center office building in Lower Manhattan may have given some closure, but these atrocities will always hold a significant place in history.

First, foremost and most importantly 9/11 was a tragic and huge loss of life. The lives of the victims' families and friends shattered forever. Many colleagues lost their lives whilst doing their jobs.

The use of aircraft as weapons has also changed aviation for everyone forever. One vital safeguard was the introduction of fortified cockpit doors which must now be locked on all flights. With effect from 1 November 2003, ICAO Annex 6 was amended so that under Chapter 13.2.2 *"all passenger-carrying aeroplanes of a maximum certificated take-off mass in excess of 45 500 kg or with a passenger seating capacity greater than 60 shall be equipped with* *an approved flight crew compartment door that is designed to resist penetration by small arms fire and grenade shrapnel, and to resist forcible intrusions by unauthorised persons*. Visits to the cockpit by passengers, once a highlight of the trip for many children, and adults alike, could not be allowed anymore. This however, enabled another tragedy to occur with the German Wings crash utilising the locked door policy to bring the aircraft down. This in turn led to the mandate that no single crew member can be ever left alone in the cockpit. This practice had already been introduced by many airlines but became formalised in 2015 when EASA issued a Safety Information Bulletin

There are now daily frustrations which affect all flight and cabin crew, as well as passengers, and in fact, anyone whose daily work takes place airside. You cannot take a drink with you on your flight, or even a yoghurt or soup for your lunch. You cannot take your metal knife and fork, or your tweezers or nail scissors. You cannot now take a bottle of wine or a gift set of perfumes as a present in your hand luggage. There are, to this day, often long queues and hold ups to get through Security Screening, with the optimum way to conduct this and new measures constantly being developed and introduced. This is accepted by us all as the price we pay for security at the highest level we can have, to ensure, as best as possible, the safety of colleagues and passengers alike.

In the early days following the introduction of these heightened security measures there were many flight safety reports filed, citing stress caused to flight and cabin crew by the intrusive security; however, the UK Authority felt a Mandatory Occurrence Report would be applicable only if a safety event had occurred directly as a result of this added stressor. In the context of bringing security to the highest possible standards this may seem on the face of it, trivial. However, add this to the other stresses placed on crew and it is understandable that they found this a difficult addition



to their busy day. It all adds up. Like all changes, these procedures now seem to have become so common place to be accepted as part of daily life. In other words, people have become used to, and accepting of, these procedures.

When the locked cockpit door was first introduced there were many concerns on how this would affect CRM, and would communications between flight deck and cabin be adversely affected. The short answer is Yes they have been, but procedures have been adapted and crews have worked together to mitigate any adverse effects. Over the years CRM training has been conducted both with flight crew and cabin crew together and separately, with arguments for the benefits of both being put forward. It can certainly be helpful to utilise this training opportunity to gain maximum insight into the roles and demands of both crews by joining forces. There are also safety benefits to be found in the extension of an investigation to include input from all crew members together, where communication between flight crew and cabin crew may have caused a level of confusion. Putting all crew together for an extended debrief is an excellent means of understanding the specifics of roles required by both in a non-normal scenario. So yes, we have had to adapt post 9/11 but there is a usually a way to work around any barrier, physical or otherwise.

It is a very different world we live in nowadays in many ways. Pre 9/11 highjack was generally thought of as a means by which a passenger may try to get taken to a specific destination or, to hold the aircraft's passengers ransom for large payouts. Before then an aircraft had never been used as a weapon, so this gave the 9/11 terrorists the element of surprise.

Air travel used to be an exciting adventure, part of the holiday, not getting from A to B as cheaply as possible. Seats with extra leg room were politely requested check-in not sold for as much as anyone will pay.

Travel to the United States declined for three years after the 9/11 attacks, then tourists began returning in larger numbers than before the attacks. Outbound tourists also subsequently increased.

So what is perhaps the biggest change since 9/11 is the attitude of our passengers; no longer are the passengers a passive group, with both positive and negative consequences. This happened very quickly, in fact by the time the fourth aircraft was taken over by the terrorists over Pennsylvania. A brave group of passengers on the United flight prevented their hijackers from using this aircraft as the weapon where they had planned. A few months later the 'shoe bomber' was subdued by passenger intervention.

So following the 9/11 attacks are we safer than we were before? Well, there are many new security measures in place, including body scanners, body searches, removal of boots and jackets and scarfs', scanning of laptops and tablets; the list is long.

As alluded to earlier the post 9/11 economic downturn took several airlines out of business altogether, and for those who survived, previously unheard of charges were introduced – paying to check in baggage, for instance, and goodbye to complimentary food and drinks on many flights. On line check-in has become the norm with many airlines, with often a significant charge if a passenger requires a boarding pass printing out at the airport.

The change to ICAO Annex 6 with the introduction of the locked cockpit door policy was considered to have potential negative consequences by many at first. The issues such as crew resource management, comfort breaks for crew members in a secure cockpit and pilot incapacitation were all thought to be negative consequences of the introduction of this new policy. However, as with all changes new standard operating procedures were introduced to mitigate the negatives. New communication protocols were introduced; communications between flight deck and cabin utilising the interphone and enhanced consideration given to this task. Procedures were also introduced for the door only to be opened for a legitimate reason, and for it to only remain open long enough for a crew member to enter or leave the cockpit. Crew were made aware that potential perpetrators may generate a disturbance in the cabin to distract crew, and in such circumstances the flight crew should remain in the flight deck with access denied.

Crew briefings at the start of duty took on greater importance to mitigate the CRM issues introduced by the physical barrier to crew communication. Opportunity to get to know other crew members, such as on a crew bus, also took on more significance, as well as flight crew members trying to find time to walk into the cabin pre-flight to make acquaintances. Whichever practices work best have now long since been adopted; optimum solutions have been found to aid communication and the best operating procedures have been introduced.

We must remember though, what is undeniably true is that Commercial aviation has a safety record to be proud of, which beats all other modes of transport, despite these tragic fatalities. And where changes are necessitated the aviation industry will find a way to adapt. Management of Change... a very important part of any Management System.

The Inflight Damaged Window Scenario

by Capt Giles Wilson and Capt Mark Boardman, DHL Air

There are few things in life more focussing than cruising along at 36000', 500mph with an outside temperature of around -50˚C when suddenly 'bang!' the Number 1 window cracks or 'catches fire'.

The result is, unsurprisingly, a general wish to resolve the situation quickly. However we should also know, buried deep in the subconscious, that as the window is a vital part of the aircraft structure and systems it has redundancy. With this in mind, and knowing that there are no recall items for this event, we can afford some time to take stock of the situation.

QRH for B757/B767

Our first point of risk assessment for this event is the QRH which is shown here. It can be seen that there are no recall items nor is the checklist listed in the quick action index. There is no requirement for haste either to complete the actions or make a plan. We can confidently say there is no immediate danger to the aircraft (QRH CI Section 2).

If the window is just arcing and the action taken in step (1) of the QRH is to select window heat off on the affected window, then it's possible the outer heated pane may subsequently shatter or crack. Although this looks disconcerting, Boeing say that the outer glass of the windshield is non load bearing so this is no cause for alarm. The next item (2) is checking that the window is structurally secure and not leaking. Boeing say that flight deck windows may deform

Window Damage

Condition: A flight deck window has one or more of these:

- An electrical arc
- A delamination
- A crack
- Is shattered

1 Choose one:

◆Window is **arcing, shattered, or cracked**:

WINDOW HEAT switch (affected window)....................Off

Removes electrical power to prevent arcing.

Do **not** accomplish the following checklists:

WINDOW (HEAT)

▶▶Go to step 2

◆Window is **not** arcing, shattered, or cracked:

▶▶Go to step 2

2 Choose one:

◆Damaged window is **deformed or** an air leak is **observed**:

▶▶Go to step 3

◆Damaged window is **not** deformed and an air leak is **not** observed:

■ ■ ■ ■

3 *Declare an emergency and plan to land at the nearest suitable airport.*

4 Choose one:

◆Airplane altitude is **above** 10,000 feet:

Descend to lowest safe altitude or 10,000 feet, whichever is higher. This minimises forces on the window.

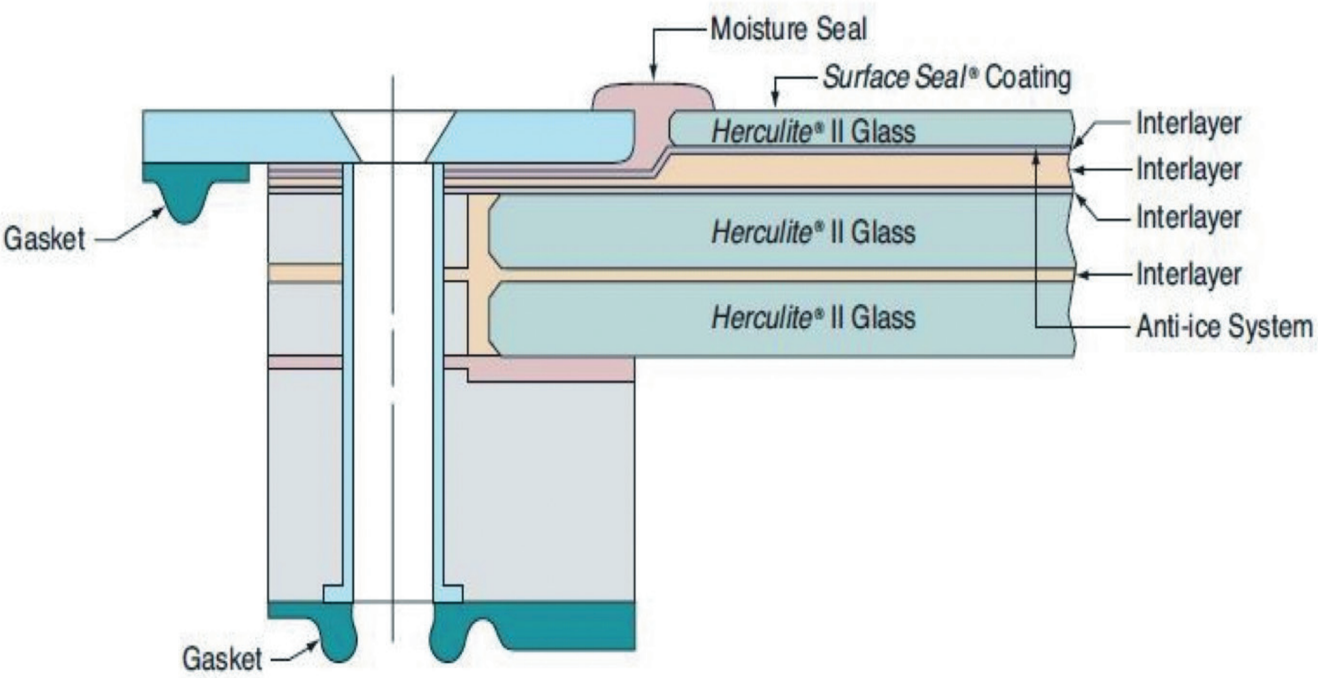
▶▶Go to step 5

◆Airplane altitude is **at or below** 10,000 feet:

▶▶Go to step 5

5 Sustained flight below 10,000 feet is not recommended due to greater risk of bird strike.

■ ■ ■ ■

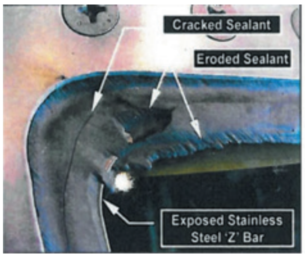


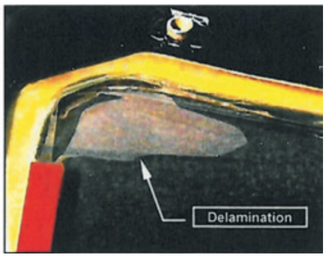
up to ½ inch (13mm) normally and a deformation greater than this will be obvious. A pressurisation leak will also be obvious and audible. If neither exits then we can safely continue at VMO/MMO/ bird strike protection speed, enjoying full windshield protection all the way to destination.

L1 & R1 Window Construction

As you can note from the cross section above, the front windshield has 3 'Herculite II' glass panes. The thinner outer layer, is not load bearing and is heated on the inside surface for anti-icing and anti-fogging. This is the only pane to come into contact with electrical power and is separated by an interlayer from the middle full thickness load bearing pane. This is, in turn, separated from the inner load bearing pane, thus there are two load bearing panes in the window. Damage to any single pane does not affect the ability of the window to carry operational pressures. However in the majority of cases it is the outer pane that is the only one affected.

A common cause for windshield problems is the moisture seal, the external seal between the windshield and the aircraft structure. This seal acts as an 'aerodynamic smoother' and moisture bar to the laminate. This moisture seal degrades over time and can allow water ingress to the 'Z-bar' or windshield laminate. This can result in de-lamination and/or arcing of the heating system. See Figures at the top of next column.





The conclusion that we can arrive at, from this description and the QRH, is that the outer pane is expendable as a part of the aircraft structure. Indeed Boeing have gone further and, in a technical notice to operators, said that:

'Since the dispatch allowance cannot be placed in the applicable MMEL/DDG, Boeing has received numerous different request for statements of No Technical Objection for dispatching a airplane with a damaged outer pane.

In many cases, Boeing has been able to grant these request.'

DHL MOC have stated that they would never advise you to divert for a windshield failure and, depending on the damage, could defer the defect to allow an onward sector in accordance with the AMM. This would be weather dependent, as the aircraft would be unable to enter icing conditions.

Effective crew actions in the event of a windshield failure

Having now completed the QRH and decided that the inner glass is neither deformed nor leaking; we can conclude that the aircraft is not in immediate jeopardy. Next we should consider operational concerns such as it could be that the pilots view out of the window is obstructed, or may become obstructed if a descent through icing occurs. The landing should be planned accordingly with the PF being the best positioned to see ahead! It may be prudent to plan for an autoland with this in mind. Also, if the Capt's window is obstructed taxiing may not be possible so it may be necessary to ask for a tug and tow bar to meet the aircraft on the runway, or to pull onto stand.

Date	Reg	Divert	Arc	Crack	Comments
11/08/2004	GBMRF	CPH	Y	Y	Orange/Red glow (arcing?). Outer pane shattered. Diverted to overhead airfield.
25/09/2004	GBIKF		Y	Y	Arcing + shattering. QRH actioned, continued to destination.
20/06/2005	GBMRA		Y	Y	Arcing + shatter. Pan. Expeditious approach requested to destination.
28/06/2005	GBMRD	NCL	Y	Y	Arcing + shatter. Oxygen mask donned, mayday declared. Diverted in NCL.
11/06/2006	GBMRJ		Y	Y	Arcing + Shattered. No leaks or distortion so continued to destination at FL250.
27/09/2008	GBIKF	BRU	Y	Y	Arcing + Cracking of outer pane.
15/06/2009	GBMRA	LEJ	Y		Arcing, no shattered, diversion requested due lack of Mx support.
05/12/2009	GBMRD		Y		Arcing, no shattered. No diversion.
18/05/2011	GBIKU	LYS	Y	Y	Arcing + shattering of outer plate. PAN + diversion.
01/08/2012	GBMRA	TLS	Y	Y	Arcing + shattering of outer plate. Capt considered it deformed. PAN, diverted.
03/08/2012	GBIKM		Y		Arcing, no shattered. No diversion.
05/04/2013	GBIKO		Y	Y	Arcing + shattering of outer plate. Not deformed. No diversion. No PAN.
30/05/2013	GBMRA		Y	Y	Arcing + cracking. No diversion.
14/02/2014	GBMRD		Y		Arcing, no shattered. No diversion.
11/10/2014	GBIKI		Y	Y	Asked Ops preferred option, continued to MAD.
14/10/2014	GBIKM		Y	Y	Continued to destination, FL100 250 kts.
15/09/2015	GBIKZ		Y		Arcing, no shattered. No diversion.
03/03/2016	GBIKO	MAD	Y	Y	Arcing + shattering. PAN + diversion.
30/05/2016	GBMRE	ARN		Y	No arcing, shattering of outer plate. NO PAN, but diversion (turn back).
27/06/2016	GBMRC	BRU	Y	Y	Arcing + Cracks. No QRH actions. Diverted.
05/07/2016	GBMRB			Y	RH Windshield shattered - Not deformed or leaking.

After the pilot aspects have been considered then commercial decisions can be addressed. Operations should be appraised of the situation and they will liaise with MOC so a commercial plan can be implemented. Although the normal default position in this case is to continue to destination, they may wish a diversion based upon engineering or freight considerations. The decision to divert (and where to) however, as in all things, is always the aircraft commander's.

Cracked Window History

Since 2004, in DHL Air, we have had 21 Number 1 window failures in flight as shown in the table. Data on which pane was cracked or shattered is not always recorded, but where it exists, it's always the outer pane. However what we do know is that on NO occasion did crew report pressurisation issues or visible bowing of the inner pane. In 9 cases the crew diverted, but only 1 was at the request of flight operations so the other 8 could be construed as unnecessary. In some cases the crew descended, slowed down or both presumably to reduce window loads, but this is not required by the QRH. In other cases where the crew diverted due to concerns about structural integrity as listed in item 2 of the QRH, they either didn't declare an emergency, descend to FL100 or both as directed by the QRH.

Conclusion

The windshield system is as robust as it is dramatic, when it fails. However it is designed to fail in the outer, non-load bearing, section. This may be as a result of electrical arcing and if so sparks, smoke and a burning smell can be expected. If the window heating system fails, or is turned off as directed by the QRH, then it's possible the outer pane may fail with a loud bang or crack and crazing of the windshield. However, whatever the event, unless pressure is escaping out of the window area or the glass is visibly and obviously deformed then there is no reason to doubt the integrity of the windshield.

With this in mind it is important not to rush a decision, but complete the QHR, and then make any decisions based on fact rather than emotion. When time permits, operations should be informed as they might have commercial or maintenance considerations. Consider icing conditions and who should be PF for the arrival and landing. If an autoland is considered then remember that it can be completed from either the left or right seat (weather permitting). Finally, remember that the flight is not over after the landing but taxiing must be considered, too. If visibility is compromised from the left seat then, after clearing the runway and judiciously taxiing to the stand area, it may be prudent for a tow onto stand if safety is impaired by continuing.

As a final note, I have as FSO for DHL Air, never heard from any operator (including Boeing) of a windshield failure resulting in pressurisation or structural integrity issue. I hope this can set the minds at rest of anyone who experiences this often dramatic and stressful event.

Reprinted with kind permission from DHL Safety Digest Spring/ Summer 2016

Lining up the benefits: Assessing the impact of One year of Time Based Separation at Heathrow

by Andy Shand, General Manager Customer Affairs at NATS

Since its introduction in March last year for Heathrow Airport, NATS' revolutionary new Time Based Separation (TBS) arrivals system has been saving time and money for all of the airlines using Europe's busiest airport. Not only has TBS helped reduce delays for air travellers but it has also added resilience to a flight arrivals schedule that is full to bursting – the airport consistently operates at 98 per cent capacity, facilitating a total of more than 1,350 aircraft movements every day of the year.

One year on, NATS' Andy Shand reflects on the new system's track record and considers some air traffic management doors that are being nudged open by the new TBS technology…

Our air traffic controllers have been using Time Based Separation for a full year for Heathrow approach. The system is in use at all times and its success is undeniable. More than 80 per cent of aircraft landing at Heathrow Airport were able to safely land closer together than they would have with traditional distance based separation. In strong wind conditions (headwinds of over 20 knots) our analysis shows that we typically save an equivalent of 180 nautical miles of separation space between arrivals in a day. As an average in all wind conditions we are seeing about 78 miles saved per day and if you think that typical spacing between medium sized aircraft is 3 miles, you can see how that equates to recovering the landing rate. Crucially there has been no increase in aircraft go-arounds or wake turbulence encounters under the TBS regime, and no adverse pilot enquiries or comments, and a reduction in flight cancellations overall.

Overall we are seeing over a 50% reduction in air traffic flow management wind delays and Heathrow controllers were able to achieve an average of 1.2 more movements per hour across all wind conditions – in strong wind conditions this hourly rate increase rose dramatically to 2.9 more movements than was previously achievable using traditional distance based air traffic control separation methods.

In November alone we estimate that, despite winds of up to 60 knots on final approach, TBS saved 25,000 minutes of delay – on 10 November in particular, despite a 40 knot headwind we had no flow regulations in place, a situation that would have been unthinkable under the old distance based regime.

All this adds up to a better service for passengers and a smoother, more efficient operation for everyone. Airline schedules are more robust under TBS, and as the TBS system dynamically adjusts spacing to reflect the actual wind conditions it also increases spacing in still winds or tailwinds when the risk of wake turbulence encounter is higher, thereby enhancing safety. In addition, we also estimate that CO_2 savings as a result of reduced holding times are in excess of 3000 tonnes. The new system has been implemented without the need for cockpit adaptations or pilot and crew re-training as we have taken care to keep the flight crew procedures the same. And as we developed the system with the Air Traffic Controllers themselves, it only required on average 2-3 days training per controller.

So, how does the system work? From the outset, NATS and our partner Lockheed Martin were determined to devise an innovative solution to provide resilience to the airport and to unlock runway capacity, safely and simply. As with many of history's landmark inventions, the scientific principles are straightforward: aircraft travel more slowly over the ground when flying into strong headwinds, like boats battling against the tide or pedestrians walking the wrong way along a moving walkway. Furthermore, wake vortices decay and dissipate much more quickly in headwinds, effectively blown away by the force of the breeze. Therefore, in strong headwind conditions it is possible safely to land aircraft closer together in distance, basing the required separation instead on a measurement of the time it takes for the preceding aircraft's wake vortex to decay to such an extent that the next aircraft in line can follow without encountering turbulence. Runway occupancy is not an issue as the aircraft are never separated in time by less than they would be in light winds.

Sounds simple? Basically, it is – but clearly, with safety at the forefront of our minds, a great deal of work and research has allowed us to develop the detailed, accurate and extremely precise tools that lie behind the successful operation of TBS at the world's busiest two-runway airport.

In order to prove that it was safe to apply Time Based Separation we carried out 5 years of LIDAR data collection at Heathrow, measuring the wake vortices from all aircraft types in all wind conditions. This produced a reliable framework of time based separation rules. In addition we needed to know what the actual winds were on final approach rather than relying on meteorological models. As part of the TBS "engine" we developed software to calculate the actual wind based on the downlinked aircraft parameters that we get from our existing Mode S Radars. The TBS tool itself then presents dynamic separation indicators to the controller that are adjusted to 0.1nm increments matching the allowable separation precisely to the prevailing wind conditions.

As an example using TBS in moderate wind conditions Heathrow controllers are able safely to land heavy-heavy arrival pairs five per cent closer together in distance than was previously achievable. Heavy-medium arrival pairs can also be safely landed five per cent closer together in moderate headwinds. In strong winds of about 35knots TBS has an even more pronounced effect, as heavy-heavy pairs are now able to land eight per cent closer together.

The extensive background research also eliminated runway occupancy as an issue, as the arriving aircraft are not crossing the runway threshold at a higher rate than they would in light winds using a distance based separation model.

The headline success of TBS at Heathrow has been the consistency with which potential wind-induced air traffic delays and flight cancellations have been avoided without compromising in any way the excellent safety record of the airport. Reputational benefits and tangible cost savings accruing from reduced fuel burn have made the new system popular with the airlines and aircraft crews, able to adopt the new system with very little adjustment, have given TBS the thumbs-up.

During its first year of operation, TBS has also gained prestigious recognition from our aviation and engineering industry peers. In November, NATS and Lockheed Martin won an Institution of Engineering and Technology 2015 prize for the year's Best Transport Innovation, an accolade of which we are immensely proud. Earlier this year, in March, the implementation of TBS earned an IHS Jane's ATC Runway Award for NATS, Lockheed Martin and Heathrow Airport and, separately, TBS was honoured at the CANSO World ATM Congress in Madrid. As part of the inaugural European Commission Single European Sky conference NATS, Lockheed Martin, Heathrow Airport, and the European Organisation for the Safety of Air Navigation (Eurocontrol) were hailed as joint winners of a Single European Sky Award for the development, introduction and operation of TBS. We are delighted to have been recognised for what we and our partners have achieved. By working together on TBS we've been able to take Single European Sky air traffic control Research (SESAR) concepts off the drawing board and into real life operations, helping to bring a Single European Sky one step closer to reality.

At Heathrow, the benefits of TBS have been significantly enhanced by working with the airport and the airlines to improve adherence to ATC speeds on final approach and with the support and cooperation of carriers and airline pilots, compliance at Heathrow has improved by 20 per cent since the introduction of TBS – currently approximately 80 per cent of arriving aircraft comply with ATC speed instructions to within 5 knots.

Here at NATS we are pleased and proud to have garnered the approval and enthusiasm of our partners and customers. Before our Heathrow approach controllers adopted TBS, the airport was arguably the best in the world at delivering optimum separation on final approach – since TBS, this excellent performance has further improved, with controllers managing to land flights consistently closer than ever before to optimum separation. The electronic TBS decision support tools were designed to assist controllers and they are exceedingly effective, in large part thanks to the ongoing involvement of a core team of experienced controllers whose professional input was instrumental in shaping the system from the start.

Strong and unwavering support from the CAA, Heathrow Airport Limited and the carriers and crews that use the airport, in particular British Airways, has helped NATS and our technology partner Lockheed Martin shape TBS to fit the task at hand – the user-friendly design is absolutely the result of close collaboration both with those who use the system every day and those whose business benefits from its safe and trouble-free operation.

One of the strengths of the new separation regime, and an aspect that greatly augmented the ease of its implementation, is that no changes to aircraft cockpits or flight landing procedures are required in order to accommodate TBS. Crews need only be made aware that we have switched away from using a traditional distance based separation and that they will be closer to the aircraft in front in in strong headwinds but that it is perfectly safe to do so.

The safety of passengers and crew is of paramount importance to everyone involved with the new TBS system, indeed the search for greater and greater safety performance was one of the drivers of the design. So far, TBS has had no negative impact on safety at Heathrow – although by distance some aircraft land closer together, by using a dynamic approach to applying the optimum separation for the prevailing weather conditions, TBS has enhanced the safety of arriving aircraft and thereby of the airport as a whole. Not only has there been no increase in last-minute aircraft go-arounds nor in wake turbulence encounters but also, of the reported wake turbulence encounters that did occur during the year, none were associated with TBS issues. Runway occupancy remains unchanged as arriving aircraft cross the threshold at a constant and predictable rate.

The air traffic control advances that have been achieved with TBS are paving the way for further developments in airport aircraft traffic flow – so, what's next? We anticipate that application of TBS tools and technology could lead to significant improvements in at least four specific areas; taking these potential TBS-based enhancements as a whole, we believe the aviation industry is on the brink of benefitting from a refocused concept that we call 'Intelligent Approach'.

With our partners at Lockheed Martin, NATS has already been speaking to international airports and air navigation service providers across the globe, working with them on developing specific ATC enhancements designed to bring tangible benefits to their operations and their businesses – and it has become crystal clear that the benefits of separating aircraft dynamically by time extend far beyond simply minimising headwind delays.

The concept of 'pairwise' separation will further enhance the efficiency of TBS by enabling the wake vortex separation to be individually tailored to the specific aircraft pairing. This will move from today's six wake categories which group aircraft together to a very granular grid which could be 70 or more individually tailored pairs. Clearly a controller could never be expected to hold that level of complexity in their head but the highly sophisticated TBS tools make it possible for this practical limitation to be lifted. Theoretically, at least, there is no limit to the level of granularity we can reach, potentially drilling right down to individual aircraft models and variants allowing new runway capacity to be created.

TBS tools could also bring potential benefits for mixed-mode operations: by integrating TBS technology with airports' departure management systems to take account of aircraft runway occupancy on departure, inbound separation could be safely tailored within mixed-mode operations. Optimising the space between arrivals based on this method could potentially deliver up to two additional movements an hour at single runway airports. Dependent runway operations could also benefit from the application of TBS tools, as the technology allows final approach spacing on converging runways to take cognisance of departures and thus goes some way to ensuring the de-confliction of go-arounds.

Furthermore, adopting the Intelligent Approach could have a positive impact at airports during periods of low visibility. Harnessing the technology could allow final approach spacing to be tailored to the preceding aircraft's impact on the localizer, thereby recovering some of the capacity lost due to fog and optimizing runway occupancy in LVP conditions.

This really is the start of a journey and there will be lots more to come.

About the Author: *Andy Shand has been General Manager of Customer Affairs at NATS since he joined the organisation in 2007. Key elements of his role – which is the focal point for NATS Airline, Business and General Aviation customers – include consultation with customers on RP2, Future Airspace Strategy, NATS Long Term Investment Plan and the Operational Partnership Agreement.*

A Fatal Illusion

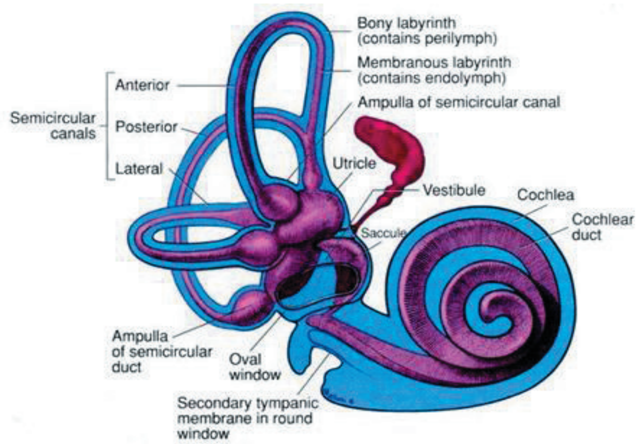
by Simon Ludlow, Dragonair

Ari qiyah Fusut 771 Guardian Newspaper.

On the night of 12 May 2010, an Air Afriqiyah A330-200 was conducting a VOR approach onto Runway 09 at Tripoli Airport with the First Officer acting as the Pilot Flying (PF). On reaching MDA, the approach was continued despite the required visual references not being obtained and at 280ft, the GPWS sounded *"Too Low –Terrain"*. The Captain ordered the First Officer to go around, which he did by disconnecting the autopilot before pitching up and applying TOGA thrust. During the Go Around, the aircraft climbed to 450ft before the First Officer started to pitch down, ignoring the Flight Director (FD) commands. Soon after, the GPWS triggered a *"Don't Sink"* alert, but the captain also moved his side stick forward, also pressing the takeover button over-riding the First Officer. At 180ft, the situation became apparent to the Captain and he attempted to pitch, but too late and the aircraft impacted the ground in a nose down attitude at 260kts. All but one of the 104 people on board died.

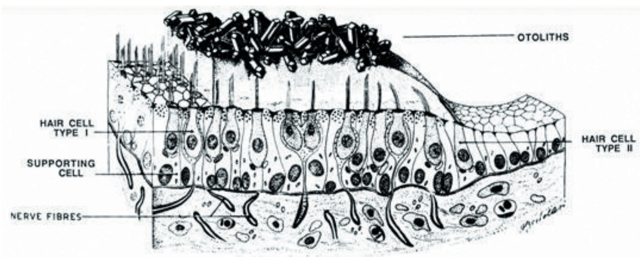
What could cause a very experienced crew to fly their fully functioning aircraft into the ground? The accident report cited a spatial disorientation phenomenon known as the somatogravic illusion. This illusion has been known since the 1940s and is far from uncommon. In fact, it has been a causal factor in 7 large airliner crashes since 2000, and many crashes to other aircraft types. So what is this illusion and why is it continuing to kill in this allegedly enlightened age of safety?

The cause is a function of the human body, which has evolved to detect acceleration from breaking into a run from standing still, but not the sustained acceleration achieved by mechanised transport. The balance; or vestibular organs in the ear can detect roll, pitch, yaw, tilt, gravity and acceleration, but because of their physiology, can only tell the brain that it has sensed a momentary acceleration, after which it can become confused as to the real nature of the movement.



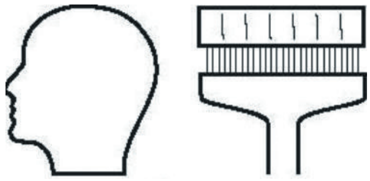
The physiology of the inner ear. (Skybrary.net)

The tilt and acceleration detection mechanisms are the otolith organs - the saccule and utricle in the vestibule of the inner ear. They consist of a mass of calcium carbonate pieces suspended on a gelatinous mass, which has embedded hairs connected to nerve endings. If the head tilts, the inertia of the mass bends the nerve endings which send a signal to the brain which is interpreted as a pitching up or down. If the motion is a linear acceleration, then this is correctly sensed. However, if the movement persists more than a few seconds, the deflected nerve endings continue to send signals to the brain which may be falsely interpreted as a pitching up instead of acceleration. In good visibility, this isn't a problem as sight provides about 80% of orientation and the sensation is suppressed. But where there are few or no visual references, this pitching illusion can take precedence, which may lead the pilot to make a nose-down pitch input. And it doesn't take much to give a significant pitching illusion. Acceleration of only 30kts over a period of 10 seconds will produce a lateral acceleration 0.16g which translates into a perceived pitch up of 9°. As many aircraft will climb at an angle less than this, the aircraft can easily enter a descent if the pilot is affected. Pilots who have survived an encounter with the somatogravic illusion report that it is powerful and takes strong will and discipline to overcome. It can convince them that their attitude indicators and flight directors are wrong and ignore warnings from another pilot or on-board safety systems such as the GPWS. In more extreme cases, pilots have had the sensation that they have pitched all the way over to an inverted attitude.

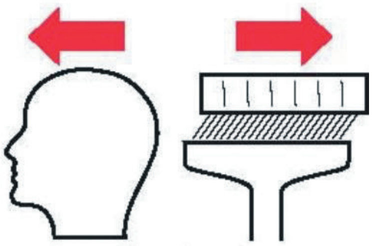


The Otolithorger (www.d.umn.edu).

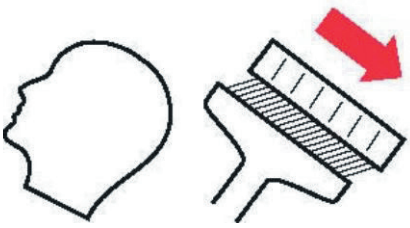
In level un-accelerated flight.



Acceleration leads to the otolith moving rearwards.



If the acceleration is sustained and there are no visual clues, the sensation can lead to a pitching up illusion.



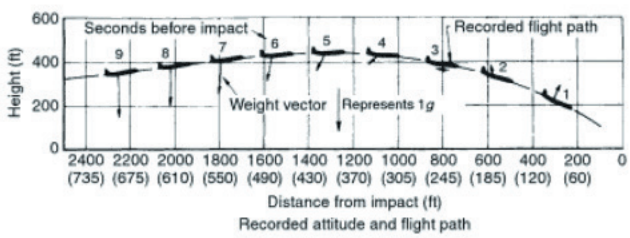
A study of over 180 SGI accidents since the 1940s reveals some sobering facts. It had often been assumed that only the pilots of high performance aircraft are susceptible, but the range of types involved stretches from humble Piper Cherokees through helicopters, to fighter jets being catapulted from aircraft carrier decks - and of course airliners. Also, the Illusion is no respecter of experience with accident pilot hours ranging from 135 to 27,000. Another statistic is that these accidents have a fatality rate of about 85% - so very few pilots who have crashed can explain what happened to them.

Most occur in the take-off phase or where a go around is being performed in limited visibility, often at night over a surface with limited visual clues such as the sea, or sparsely populated area with no lights. While smaller general aviation aircraft tend to succumb during the take off phase, the majority of recent jet airliner crashes have occurred during a go-around. There could be several reasons for this, one being that the high energy go-around is an infrequent and rarely practiced manoeuvre.

To understand how the illusion can pose such a threat, it's useful to look at two cases. In 1965, in an accident similar to Air Afriqiyah's a Vickers Vanguard (registration G-APEE) had already gone around twice due to fog and was making a third approach at LHR. Despite a reported improvement in the visibility, this third approach also

Vanguard G-APEE (Peter Davs Collection).

resulted in a go-around. The First Officer was the PF with the Captain acting at Pilot Monitoring (PM) and being prepared to take control for the landing once visual, as per the company Standard Operating Procedures. As the First Officer pitched up, the Captain raised the flaps to 5° instead of the standard 20°. The First Officer had to reduce the pitch attitude to accelerate and it is at this point that he probably succumbed to the somatogravic illusion. He pitched down again causing further acceleration and more likely than not, exacerbated the problem with a stronger illusion. A further two pitch down inputs initiated a descent and sealed their fate with the aircraft impacting the runway, killing all 36 people on board. This accident is significant as it is the first somatogravic illusion incident to be captured on a Flight Data Recorder. However, the accident investigation didn't consider it to be a factor – probably because the illusion was not widely understood at the time. The report cited fatigue and misinterpretation of the instruments amongst seven probable causes.



G-APEE's descent profile (Ernsting).

Another more recent incident involved an A320 taking off from Hong Kong at night. At the acceleration altitude, the PF pitched down. The PM noticed that the attitude was lower than the (FD) demands and pointed this out to the PF. After two more ignored warnings from the PM, the PF had continued to pitch down and the aircraft had started to descend. The PM resolved the issue by taking control by engaging an autopilot (AP). After the event, the

PF stated that they had a very strong sensation that the aircraft had a higher attitude than the Primary Flight Display indicated and he didn't believe the FD commands while failing to register the significance of the PM's warnings. This crew were very experienced with combined experience in excess of 20,000 hours, the FO knew about the illusion from training, but as the Captain had completed his training before the introduction of Human Performance and Limitations (HPL) training in the Commercial Pilot's Licence syllabus. However, neither considered it a cause of this event or realised what had caused the PF's sensory illusion until it was explained to them.

Mitigating this threat starts early in a pilot's training. The introduction of HPL training in commercial aviation started in the 1990s and a description of the SGI forms part of the syllabus, with knowledge being tested in an exam. But whereas other forms of sensory illusions such as the somatogyral illusion can be physically demonstrated in the air, inducing the somatogravic illusion is near impossible. And as simulators replicate acceleration by pitching the pilot up while maintaining the visual and instrument attitudes, they cannot simulate the somatogravic illusion if the vestibular apparatus is being convinced that it already accelerating by tricking the very mechanism which is responsible for the illusion in the first place. This means that many pilots flying today only have a distant recollection of this potential killer and only limited knowledge of how to counter its' threat.

The best defences against the somatogravic illusion are knowledge and identification of situations when it is likely to be a threat. Night take-offs or departures in poor visibility, and particularly any approach where a go-around is possible should alert the pilots. And like any other identified threat, it can be briefed. Other actions which will mitigate the threat are as follows:

- Engage the AP soon after take-off on departures at night, and/or in poor visibility.
- Engage the AP if the pitch attitude is felt as being different to that indicated.
- Leave the AP engaged until the required visual references have been established on any approach at night and/or in poor visibility.
- If going around at above minima, do not rush the manoeuvre and consider using less than full thrust.
- Fly any go-around with the AP engaged. If not, engage it as soon as possible.
- Do not disengage the AP on a go-around.
- If feeling uncomfortable – consider handing control to the other pilot.
- If PM, monitor the flight-path carefully in climb and go-around phases.

Recent industry emphasis has recently concentrated on runway excursions caused by unstable approaches - the best defence against this threat is the timely decision to go around. However, this seemingly safe manoeuvre is not without its' own threats as pilots rarely practice or encounter an all engine go-around. The SGI is still not widely acknowledged as a major cause of aircraft accidents - the industry has not yet come to grips with fully mitigating this threat despite the mounting accident data. The human body has limitations in the dynamic aviation environment and when faced with a situation it is difficult to train for; the only defence is education.

Look – no hands! US Navy F18 pilots launch hands off as a response to the threat of the SGI. (US Navy).

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Are You Missing Something?

by Dai Whittingham, Chief Executive UKFSC

Runway excursions are one of the biggest causes of hull losses in commercial aviation, and they also cause loss of life. In the last 5 years there have been at least 9 accidents and incidents involving touchdowns where one or more sets of wheels have been off the paved surface or have left it soon thereafter, or where the runway contact has been sufficiently violent that elements of the landing gear have given up the struggle and left the rest of the aircraft to finish the landing run on its own. This article does not consider several other incidents and accidents where cloudbase or visibility were not a factor. Nor does it cover the Metro III (EC-ITP) that crashed in fog at Cork in February 2011 – this aircraft's first contact with the runway was unfortunately not with its landing gear but with a wing tip following a loss of control during a late go-around, the results being fatal for most of its occupants.

A330-200, Abidjan

On 21 August 2011, OD-MEA, an A330-200 operated by Middle East Airlines, was flying from Beirut to Abidjan (Cote Ivoire) with 233 passengers and 12 crew. The captain, as pilot flying, elected to carry out an ILS approach to Abidjan's runway 21 in visibility reported at 1600m and with calm winds. Descending through 300 feet AGL the autopilot was disconnected the autopilot and the approach continued manually. Shortly afterwards the aircraft began to deviate to the right of the extended centreline and as it passed 100 feet radio altitude it was tracking parallel to but offset to the right. The aircraft crossed the runway threshold at 46 feet RA and 23 feet to the right of the runway centre line. The first officer recognized they were aligned with the right-hand edge lights of the runway and asked the captain to turn left.

About 5 seconds after crossing the runway threshold, at 20 feet RA in the flare and with the thrust levers at idle, the captain applied left aileron, left rudder and nose up control inputs. The aircraft reached its maximum deviation to the right of 33 feet (at 4 feet RA) as it began to turn left and climb again. 12 seconds after crossing the threshold the aircraft passed through the runway centreline again at 15 feet RA, pitch attitude +7 degrees and left bank of 5 degrees. 2 seconds later the captain applied right rudder inputs but the aircraft was now descending at 500 fpm. 17 seconds and 3780 feet past the runway threshold, and 62 feet left of the centreline, the left main gear touched down beyond the left edge of the runway and the right main gear touched down onto paved surface shortly afterwards. 3 seconds after main gear touch down the captain selected TOGA thrust (now 20 knots below Vref); 2 seconds later the aircraft cleared the ground again 121 feet left of the centreline. During the climb the crew asked ATC to inspect the runway lights, indicating that they may have hit the left-hand edge lighting. The aircraft entered a holding pattern at 2700 feet, while the runway inspection was being carried out. When the crew requested visibility data again, tower stated visibility was 1600 m but the crew advised it was actually zero. The local weather station then reported an RVR of 350 m (crew limit 600 m). The runway inspection did not find any damaged runway lights but the visibility prompted the crew to divert to Accra (Ghana) where the aircraft landed without further incident. The aircraft suffered only superficial damage.

A special METAR released 43 minutes prior to the occurrence reported 800 m in fog with a minimum visibility of 200 m. The METAR released 15 minutes prior to the incident reported 1600 m and the METAR 15 minutes afterwards showed 2000 m; the special METAR released 25 minutes after the occurrence recorded 400 m in fog with the trend of further reductions to 200 m.

Cote Ivoire's Autorite Nationale de l'Aviation Civile (ANAC), concluded the cause of this serious incident was the commander's decision to continue the approach despite having lost visual references.

B737-800, Mangalore

On 14 August 2012, an Air India Express B737-800 was operating at night from Dubai to Mangalore. The flight proceeded according to plan and, at 220nm from Mangalore, the crew contacted the area controller to check weather for destination and alternates (Calicut and Cochin). Mangalore was reporting 090/03 and 200m in fog; the crew required a minimum 1200m RVR. The crew was cleared to the hold at their requested FL 200 and, when established, had holding fuel of 30 mins and 50 mins for Cochin and Calicut respectively. They were then passed a manual RVR of 1200m and commenced their approach, initially to the VOR hold; passing FL 100 they were advised TWR was reporting 800m visibility and 1200m RVR, which the crew acknowledged was within minima. The crew was then cleared for the ILS to RWY 24.

The aircraft was established on the ILS passing 2100ft and 6 DME; the runway was not in sight. The crew was asked to report finals and later received a landing clearance, wind reported as calm. At 245ft RA the captain disconnected the autopilot and continued with the approach, but a nose down input began to increase the rate of descent which ultimately reached just over 1000fpm. The increased rate of descent also took the aircraft below the 3 degree glide path. The aircraft touched down hard, right wheel first, approximately 100 ft short of the runway at 151 kts and then bounced to 20ft RA with the speedbrakes fully deployed. Some 7 seconds after first ground contact the aircraft then arrived on the runway, 1900 ft from the threshold, at 2.0g. The captain used maximum reverse thrust and braking and vacated the runway normally. There was sufficient visibility for him to taxy unassisted to the terminal.

The approach and landing were not witnessed from the tower because of the weather, and the crew did not report the hard landing. Both crew inspected the aircraft when the passengers had disembarked and observed damage to the aircraft and its wheels; the captain wrote 'Suspected hard landing' in the tech log. The CVR analysis noted the captain's comment that it would be his first approach in marginal weather; the first officer's call of 'runway in sight' was almost coincident with the 100 ft automated callout and occurred around 6 seconds after the 'minimums callout and autopilot disconnect.

A320-200, Davao

A Cebu Pacific A320-200 was operating from Manila to Davao in the Philippines on 2 June 2012. It ended its flight with a collapsed nose gear and substantial damage to the engines and fuselage from ground contact.

The captain as pilot flying Pilot Flying (PF) failed to maintain a stabilized approach in heavy rain that seriously reduced forward visibility; shortly before touchdown the aircraft was still left of the runway centreline. The first officer called him to go right (to align) but the correction was too large and the aircraft drifted towards the edge of the runway. The first officer by this time was calling for the captain to correct left for the centreline, but the captain aligned the aircraft on the right-hand edge lighting on the mistaken assumption that it was centreline lighting. Unfortunately, Davao was not equipped with centreline lighting.

In the subsequent investigation it became clear that not all the damaged runway edge lights could be attributed to the A320. At least two of them were believed to have been broken by another aircraft, a turboprop from the same operator that had landed 5 minutes before the accident aircraft and which was found to have damaged wheels. A timely report from the crew of that aircraft may have given the A320 captain, who had only made one approach to Davao in the previous 3 months, a better understanding of the conditions he was facing. The investigators also noted that the crew had not complied with their company SOPs, which (not surprisingly) required a go-around in such circumstances. There were also several non-standard calls and "lapses, omissions and contradictory words employed during the landing approach".

A330, Tangerang

On 13 December 2013 , PK-GPN, an Airbus A330 operated by Garuda, was on a scheduled passenger flight from Bali to Soekarno-Hatta International Airport, Tangerang, Indonesia. There was no reported or recorded aircraft system abnormality during the flight from take-off until the time of the occurrence; the captain was PF. The weather report for Soekarno-Hatta was moderate rain, thunderstorms, and wind direction north-westerly. During the ILS approach to RWY 25L, the crew requested a right turn to avoid a CB before descending to 2,000 ft before ILS capture. The approach was normal until 184 ft RA, when the wind direction changed from westerly to southerly, increasing from 4 kts to 24 kts up until the aircraft touched down.

At 124 ft, the autopilot was disengaged and the pilot resumed hand flying. Prior to touchdown, after the automated Flight Warning Computer (FWC) callout of "TWENTY", the first officer called "fly left" twice, followed by the FWC callout of "RETARD". During the flare the aircraft entered heavy rain and the PF lost visual reference. The PF also felt that the aircraft was floating. The PNF later informed the investigation that he could see the runway throughout and knew the aircraft was slightly on the right of the runway, hence his advice to fly left. The aircraft touched down with the right main landing gear on the right shoulder (off the pavement) where it remained for 1500ft of the landing run before the aircraft regained the pavement. There was no significant damage to the aircraft.

The investigation concluded that loss of visual references, coupled with a prolonged flare, should have prompted the crew to go around. Other than the reported thunderstorms, there had been no information to suggest conditions would be as severe as the ones the crew encountered, which may have reinforced the pilot's perception that 'he could cope'.

A330-300, Kathmandu

A Turkish Airlines Airbus A330-300, registration TC-JOC flying from Istanbul to Kathmandu (Nepal) with 227 passengers and 11 crew, had gone around from its first approach to Kathmandu's runway 02 due to fog. The crew positioned for a second approach to runway 02, from which they landed, but the left main gear touched down off the paved surface and the nose gear was also outside the runway markings although still on the pavement. The aircraft veered further left off the runway and came to a stop with all gear on soft ground; the nose gear collapsed during the runway excursion and 4 people received minor injuries in the subsequent evacuation. The aircraft was damaged beyond economic repair.

The aircraft established contact with Kathmandu shortly after ATC opened at its scheduled time. At this stage the visibility was reported as 100m and the airport was closed; the crew was instructed to proceed to the Simara hold. A further weather update 45 minutes later gave a visibility of 1000m and the crew then reported ready for an RNP AR approach to runway 03. At 0127 UTC, 20 minutes after the revised weather report, the crew carried out a missed approach having failed to gain the required visual references.

On the second approach to the same runway, Kathmandu Tower asked the crew whether they had the runway in sight. Passing 880 ft AGL the crew reported that they were unable to see the runway but were continuing; passing 783 ft, the crew asked whether the approach lights were on and were informed that all approach lighting was at maximum brilliance.

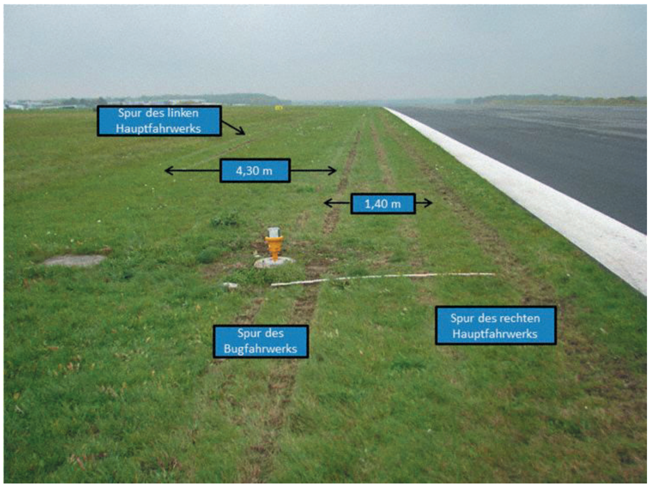
FDR data showed the auto-pilot remained coupled until 14 ft AGL, when it was disconnected for the flare. Pitch at touchdown was lower than normal at 1.8 degrees nose-up, and the peak vertical acceleration was 2.7g. It was apparent from CCTV evidence that the visibility had been steadily decreasing and was well below minima at the time of landing; the reduction in visibility had not been passed to the crew.

The investigation revealed that there were errors in the accuracy of the coordinates provided for the displaced threshold at Kathmandu which had the effect of off-setting the touchdown point and the approach alignment by 26m to the left of the centreline. There were process issues with the AIP, AIRAC and NOTAM system that meant the operator was unaware of the errors, but the investigation also noted that the RNP AR approach was not designed be flown with the autopilot coupled down to the flare and concluded that the coordinate errors would have been inconsequential if the crew had acquired the necessary visual references at MDA.

B738, Paderborn

On the evening of 20 October 2015 a Sun Express B737-800 flew from Antalya to Paderborn At about midnight, the crew established the aircraft on the ILS for runway 24 and were passed latest weather of 290/03 and 800m RVR. The METAR at 2350(L) was 29002KT 0200 R24/0650N –DZ FG VV/// 07/07 Q1022

FDR data showed the aircraft on a constant heading of 240 mag, on the centreline and on the glideslope until the autopilot was disengaged at 200ft RA. In the following 24 seconds the heading changed to 232 mag before increasing to 243 mag. Two seconds after the automated RA callout of 'ten' the first officer called for a go-around. The aircraft touched down left of the runway centreline, initially on its right main landing gear, and subsequently taxied to its planned parking position. The nose and left main landing gear were later found to have hit the runway edge lighting.



B733, Osh

On 22 November 2015, an Aviatraffic B737-300 flew from Bishkek to Osh (Kyrgyzstan) arriving at about 0756 local. The first ILS approach to Osh's runway 12 resulted in a hard landing that caused substantial damage to the landing gear, right engine and 2 hydraulic systems. The crew flew a go-around following the initial hard landing and were planning to divert, but the indications of the right engine and double hydraulic failure prompted a decision to land Osh despite the weather, which by then was reporting 50m in fog.

Shortly prior to the first approach, ATC advised that visibility had reduced to 900m horizontal/200 ft vertical. The crew opted to commence the approach. Five minutes later, there was advice that the visibility had further reduced to 500m and 100 ft; this was just one minute before the hard landing. Ground observers also noted that the fog became rapidly worse just before the aircraft arrived, suggesting horizontal visibility was as low as 150m.

The captain attempted to go around, selecting TOGA thrust 5 seconds before the runway threshold but his subsequent control inputs (possibly as a result of a somatogravic illusion) led to the aircraft impacting the runway at 3.96g before the aircraft climbed away. The original decision was to divert to Bishkek but, having lost the right engine and 2 hydraulic systems, the captain opted to return to Osh. In very poor weather, he landed 3500 ft into the 8500 ft runway. The landing gear separated along with one of the engines, and the aircraft skidded along on its belly for a further 1500 ft. All occupants survived but the aircraft was damaged beyond repair.

B733, Wamena

On 12 September 2016, a Trigana Boeing 737-300F, registration PK-YSY, flew from Jayapura to Wamena (Indonesia) with 3 crew and 15.3 tons of cargo. The airfield is at 6000 ft and has no published instrument procedures, hence all approaches should be visual. When PK-YSY arrived, a ground observer estimated the cloud base at 150-200 ft; a similar aircraft from the same operator had landed successfully a few minutes earlier.

PK-YSY was seen to break cloud, correcting to the right and pitching down rapidly towards the runway. The initial runway contact was very hard and in a high nose attitude. The left main landing gear failed and separated, the right main gear also collapsed, and the aircraft slid along the runway on its nose gear, belly and engines before coming to a halt just off the right edge of the runway. The crew members were uninjured. The accident is still being investigated and no interim report has yet been issued.

AN-26, Belaya Gora

A Polar Airlines AN-26-100 was seriously damaged in a landing accident at Belaya Gora on 13 October 2016. The aircraft touched down on the banks of an ice-covered river approximately 1200 ft short and 900 ft left of the runway in poor weather; all the landing gear collapsed and one propeller was torn from its engine during the initial ground contact.

The very experienced crew was carrying out an NDB approach that required 4000m visibility when only 2500m was available at the start of the approach. Reports suggest that heavy snowfall and gusting winds had combined to produce white-out conditions during the later stages of the approach. There were no major injuries but the aircraft was severely damaged.

Conclusion

If you don't have the required met conditions for the approach, divert or hold until conditions have improved. If you lose visual references below MDA/DA, go around immediately.

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