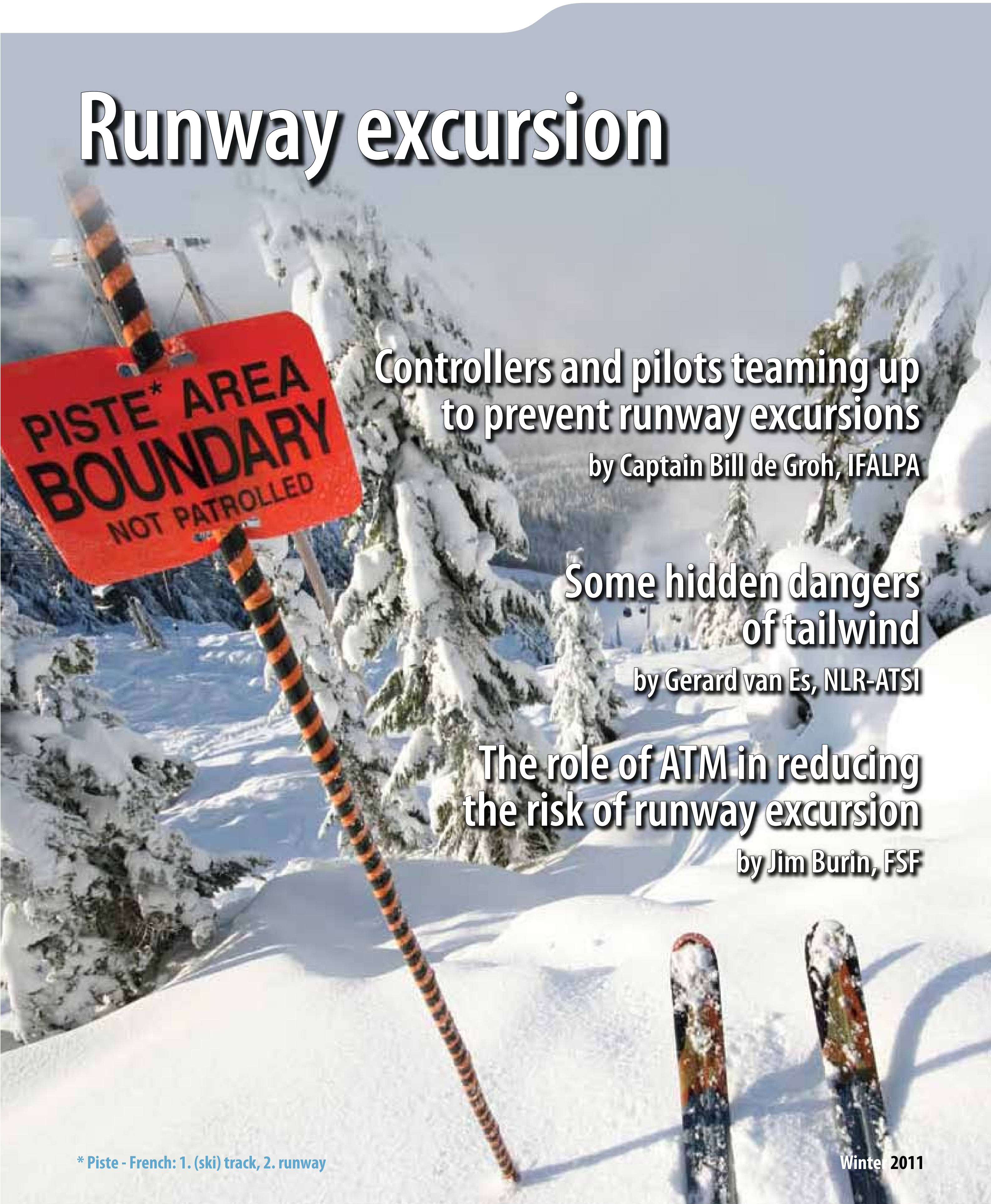
HindSight 12

The ability or opportunity to understand and judge an event or experience after it has occured

EUROCONTROL

Runway excursion



Controllers and pilots teaming up to prevent runway excursions

by Captain Bill de Groh, IFALPA

Some hidden dangers of tailwind

by Gerard van Es, NLR-ATSI

The role of ATM in reducing the risk of runway excursion

by Jim Burin, FSF

* Piste - French: 1. (ski) track, 2. runway

Winter 2011

Contents

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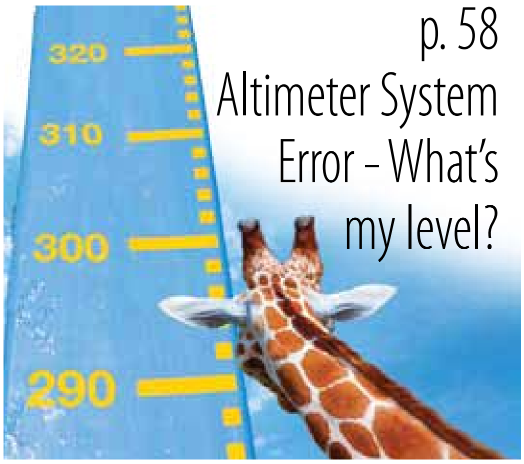

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For alligators and stabilised approaches

Tzvetomir Blajev
Editor in Chief of Hindsight
Fellow of the Flight Safety Foundation

"Once I was being led by a guide through the Everglades' wetlands in southern Florida. The saw grass prairie and the mangrove forests were beautiful but I was staying alert. *"Is it true that the alligators will keep away from you if you use a strong torch or flashlight?"* someone from the group asked our guide. *"A flashlight is fine, but your survival generally depends on how far you keep it from the alligators and how fast you carry it"*, he replied.

> The NLR studies showed that even a 100% rate for stable approaches would only reduce the total number of runway excursions by up to 10%.

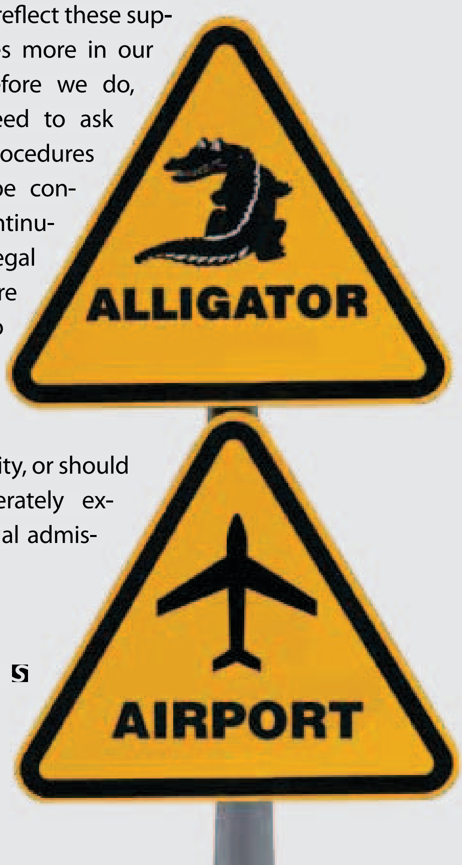
The question here is should we have a flashlight or not if the survival is not necessarily always determined by this fact? Should we make it compulsory, by law and procedures, because we know it may increase our chances, even if there are stronger survival strategies like "stay away" and "run fast"? Making it compulsory is potentially opening the litigation window for the prosecutors to take the aim at companies which are organising swamp excursions without equipping the participants with torches. Now put yourself in the shoes of people working for these companies – are you going to encourage the adoption of such procedures?

Now take another risk - runway excursion - and think of the effect ATM can have on the rate of the stabilised approaches. Sure, if the stabilised approach criteria are not met at the mandatory gate set by the Operator, then the crew should initiate a go-around. And of course, this is a more reliable strategy compared to managing the ATM influence on stabilised approach. But although unstabilised approaches have been shown to contribute to runway excursions, they only affect landing overruns. Furthermore, NLR studies have shown that these only make up about 40% of all runway excursions. Even in landing overruns, unstabilised approaches are not the most important factor. Slippery runways and long landings are much more important – although long landings and unstabilised approaches may sometimes be associated. The NLR studies showed that even a 100% rate for stable approaches would only reduce the total number of runway excursions by up to 10%.

Like flashlights in the Everglades, good ATM practice can improve the rate of safe outcomes. So should we promote ATM practices which avoid making adverse contributions to the likelihood of a stabilised approach, a long landing or problems with slippery runways? Adverse contributions include; high-speed approach clearances, not announcing the vectoring limits, vectoring too short onto the final, setting up interception of the glide path from above and not providing the latest meteorological and runway state information to the crew.

Should we also reflect these supportive practices more in our procedures? Before we do, perhaps we need to ask whether ATM procedures are going to be considered as a continuation of the legal framework. Are they going to be used as evidence when apportioning blame and liability, or should they be deliberately excluded from legal admissibility?

Enjoy reading HindSight!



HindSight 12

The ability or opportunity to understand and judge an event or experience after it has occured

Front Line Report:

Language and safety issues

By Bert Ruitenberg

Language is a wonderful phenomenon. I've attended quite a few Human Factors events where some of the participants must have felt quite out of place because essentially they were Human Resources people. Human Factors, Human Resources, phrases that are apparently easy to confuse even though I think that linguistically they're not really that close at all. At least not as close as the phrases Runway Incursion and Runway Excursion - now there's a pair of almost identical twins!

After targeting Runway Incursions as a safety subject it would therefore seem logical for the aviation industry to target Runway Excursions in a subsequent step. I'm not going to argue that Runway Excursions aren't a safety issue - far from it. What I would like to argue however, is that from a safety management perspective, there's a world of difference between Runway Excursions and Runway Incursions and that the remedial approach towards one of those safety issues is therefore not simply transferable to the other issue.

Bert Ruitenberg

recently retired from working as a TWR/APP controller, supervisor and ATC safety officer at Schiphol Airport, Amsterdam, The Netherlands.

He was recently appointed as the new IFATCA Safety Coordinator.

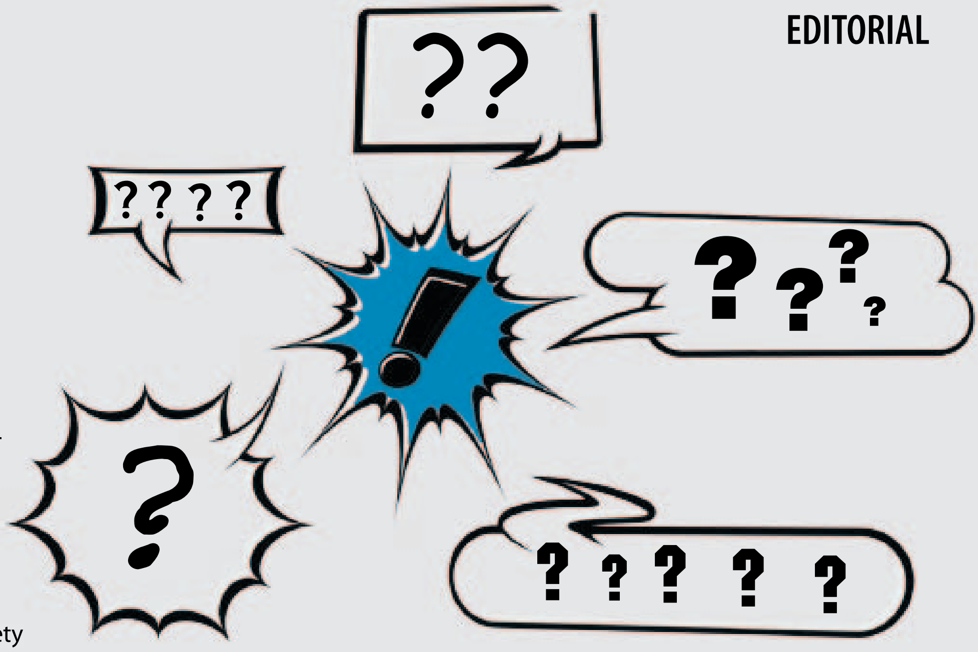
> I think ATC also has a role to play when it comes to preventing REs. Just ask yourself this question: why do pilots and their aircraft sometimes end up too high and too fast on final approach?

Allow me to start by listing a number of attributes of Runway Incursions (RIs).

They happen on the ground and they have their origin on the ground. A RI does not necessarily have to result in a dangerous situation, since it may occur on a runway that is not active or on which no aircraft is landing or taking off at the time. A RI does not have to result in any damage. In terms of the Threat and Error Management (TEM) framework, a RI is an Undesired State that can still be managed to influence the outcome. RIs may involve vehicles or pedestrians. Differences in aerodrome lay-outs, signage and markings are cited as factors in RIs. Weather does not seem to be a huge factor in RIs, except that more RIs occur in good weather conditions than during low visibility conditions.

And here is a list of similar attributes for Runway Excursions (REs). They happen on the ground but they often have their origin when the aircraft still is in the air. An RE is always a dangerous situation, because it involves a veer off or overrun off the runway surface. An RE usually results in some form of damage (either to the aircraft or to the aerodrome infrastructure or both). In terms of the TEM framework an RE is an end state that cannot be managed to change the outcome. REs exclusively involve aircraft. Runway length and runway surface conditions are cited as factors in REs. Weather is a huge factor in REs, with heavy precipitation and strong wind as recurring elements in investigation reports.

You see the differences? The lists are not meant to be exhaustive, by the way. Now let's take a look at the remedial approaches for RIs versus REs. The European Action Plan for the Prevention of Runway Incursions (EAPPRI) has led to the successful establishing of a Runway Safety Team at many European airports. In those teams, representatives from the airport authority, the major airlines based or operating at



the airport, air traffic services, and other parties who perform their daily work on the manoeuvring area, all participate with the aim to come up with recommendations for local improvements to prevent RIs.

The recommendations from the Runway Safety Teams usually focus on items such as signage and markings, ICAO compatibility, lighting and more. They may also comprise items such as the airport infrastructure, names of taxiways and/or intersections, stopbar availability and usage, aeronautical charts (airport maps) and more. Moreover, Runway Safety Teams have organised dedicated campaigns to enhance the awareness of the aerodrome users on the subject of RIs, including ATC.

All those things are good things (at least in my book) to help prevent Runway Incursions, yet very few of them are any good at all when it comes to the prevention of Runway Excursions. The simplest form of action to prevent an RE after landing is of course to execute a missed approach instead of landing. But deciding on that particular action is not as simple for a pilot as it may seem. This is where the concept of a stabilised approach comes in: if certain flight parameters are not met at a predetermined point during final approach, the pilots are supposed to execute a missed approach. Notice however, that this does not address the issue of an RE during take off.

When analysing REs that occurred during take off, the factors that are often cited include; mechanical failure, wind conditions that were different from what the pilots knew or runway surface conditions that were different from what the pilots knew. Once again it comes down to pilot decision making, except of course in case of mechanical failure.

I am therefore not convinced that local Runway Safety Teams are the best platform to address Runway Excursions as a safety issue, as proposed by some. The power of Runway Safety Teams is the local knowledge of infrastructure and procedures that may be improved to prevent RIs. But the issues around REs are more universal in nature (no pun intended), which to me suggests that a more generic approach may be required to successfully address the problem.

In fact, this generic approach is already being taken by organisations such as the Flight Safety Foundation, which provides a Runway Excursion Risk Awareness Tool (available online in Skybrary). In it they cite a "failure to recognise the need for, and to properly execute, a Rejected Takeoff (RTO) and a failure to recognise the need for a go-around and to conduct a go-around at any time during an approach, flare or touchdown" as primary factors in runway excursions. The Foundation offers several strategies that pilots can adopt to help avoid the risk of an RE.

But I would go further than that: I think ATC also has a role to play when it comes to preventing REs. Just ask yourself this question: why do pilots and their aircraft sometimes end up too high and too fast on final approach? Did we perhaps put them there, or at least did they maybe keep up the speed in response to a request from us? In other words, are our ATC procedures and working styles adequate to facilitate airline pilots to always perform stabilised approaches? And who can provide the most up-to-date weather information to pilots?

I'll leave you to contemplate those questions and return to what I started this article with: language issues. To assist in overcoming language issues the concept of a "definition" was introduced. I found the following definitions for Runway Excursion on the internet. The first one is attributed to ICAO (although I haven't been able to trace it back to an ICAO document) and reads as follows: "a veer off or overrun off the runway surface". Skybrary contains this definition: "a runway excursion occurs when an aircraft fails to confine its take off or landing to the designated runway". Wikipedia states that a Runway Excursion "is an incident involving only a single aircraft where it makes an inappropriate exit from the runway".

The whole idea of putting a label such as "runway incursion" or "runway excursion" on a safety occurrence is to make it easier to file the data from the event somewhere and to compare it with similar occurrences. With the definitions above, a take off from a taxiway would be considered as a Runway Excursion when the Skybrary definition is used, but not with the other RE definitions (and rightly so, I say, better label it a "taxiway take off"). Moreover, in the ICAO definition, the B777 undershoot at Heathrow would not be a RE, but with the Skybrary definition it would be. Dear Safety Managers of the world, there still is a lot of work to be done...

Before the runway

By Professor Sidney Dekker

> **Editors Note:** This time, we decided to invite some comments on Professor Dekker's article from subject matter experts. Their responses follow the article.

We are at 2,000 feet, on approach to the airport. The big jet is on autopilot, docile, and responsively following the instructions I have put into the various computer systems. It follows the heading I gave it, and stays at the altitude I wanted it at. The weather is alright, but not great. Cloud base is around 1000 feet, there is mist, a cold drizzle. We should be on the ground in the next few minutes. I call for flaps, and the other pilot selects them for me. The jet starts slowing down. Then we come to the top of our approach. The autopilot nudges the nose of the jet downward, onto the glideslope towards the runway.

Then something strange happens. The thrust levers that control the power to the jet's two engines move all the way to the back to their idle stop. This is very little thrust for the situation we are in, not enough for keeping the jet aloft much longer. In a split second my eyes dart up to the computer display with the various mode annunciations, which tells me what mode the various automatic systems are operating in. The autopilot is doing what it is supposed to be doing; riding the glideslope to the runway.

However, the autothrottle is another story. This is the computer that helps control how much thrust goes out of the engines and it is in a mode that I have never seen in this situation before; fully retarded. My eyes flutter down onto the display with flight information. My airspeed is leaking out of the airplane as if the hull has been punctured, slowly deflating like a pricked balloon. It looks bizarre and scary and the split second seems to last for an eternity. Yet I have taught myself to act first and question later in situations like this.

So I act. After all, there is not a whole lot of air between me and the hard ground. I switch off the autothrottle and shove the thrust levers forward. From behind, I hear the engines screech, shrill and piercing. Airspeed picks up. I switch off the autopilot for good measure (or good riddance) and fly the jet down to the runway. It feels solid in my hands and docile again. We land. Then everything comes to a sudden standstill. The screens freeze, the world outside stops moving. We are in a simulator. "Nice work" says the instructor from his little pedestal behind the two pilot seats. I turn around and smile at him, knowing that he knows what I know.

At that very moment an accident was still being investigated on which the scenario was based. A big jet crashed short of the runway because, in a one-in-a-million chance, the autothrottle was tricked into a wrong mode by some rare indication failure of the airplane's altimeter system. The radar altimeter erroneously told the autothrottle that the jet was on the ground (even though, pertinently, it was not) and that it was time to retard the thrust levers and to pull the power.

However, the autothrottle computer never bothered to tell the autopilot about its intentions. The autopilot was happily doing its thing, riding down the glideslope to the runway, blissfully unaware that the other computer system had just robbed it of the only factor responsible for being able to fly at all: airspeed. None of the books available to pilots about this jet ever revealed this possibility. As far as most pilots were concerned, it was an unknown-unknown.

But no more. Here I was sitting in a simulator for a regular four-hour proficiency session to keep my rating valid. The

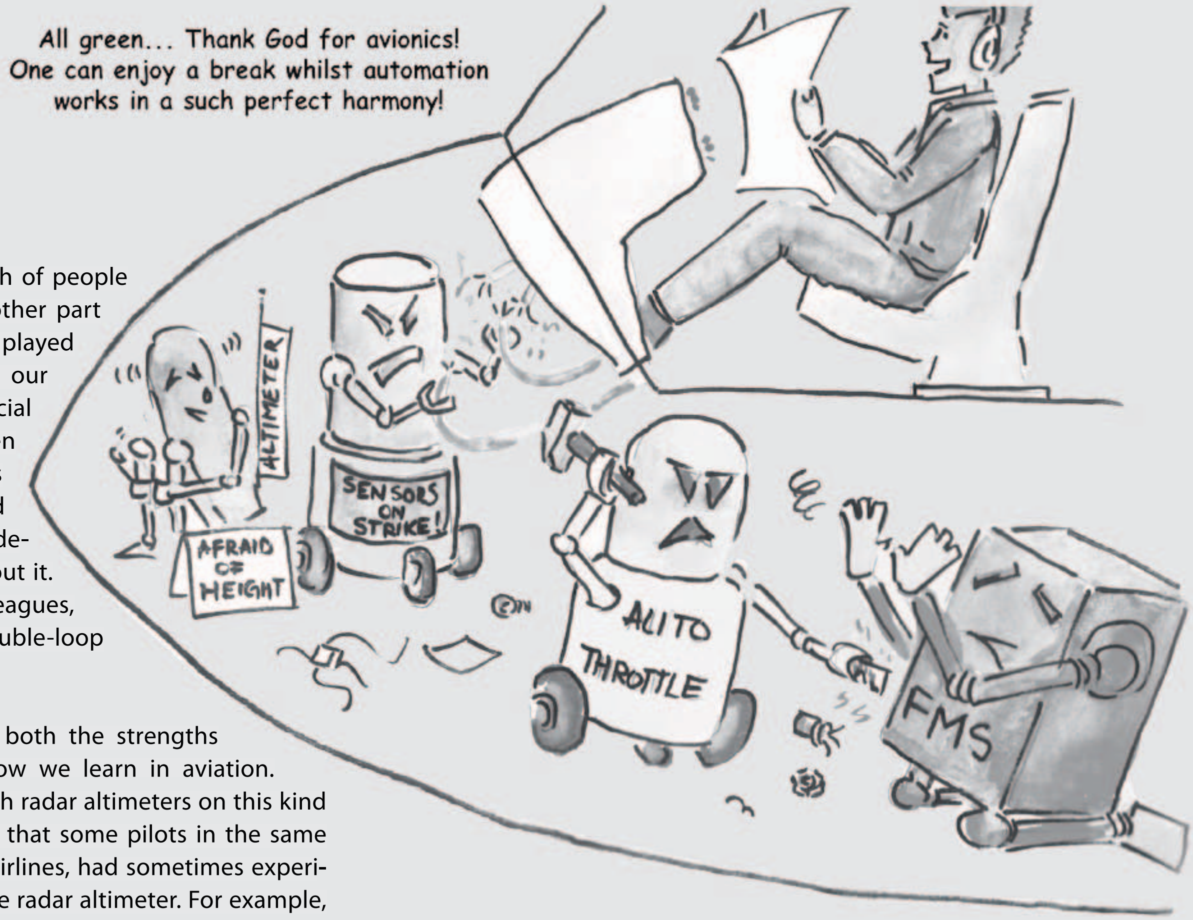
> **People are expert at adapting their readings of risk so as to make the world look more normal, less hazardous.**

Professor Sidney Dekker is Professor of Human Factors & Aviation Safety at Lund University in Sweden.

He gained his Ph.D in Cognitive Systems Engineering at the Ohio State University in the US.

His books include "The Field Guide to Human Error Investigations" and "Ten Questions about Human Error". His latest book is "Just Culture: Balancing Safety and Accountability".

He flies as a First Officer on B737NG.



scenario that killed a bunch of people in the same jet but in another part of the world was being played through our flight, into our hands and minds. The official accident report was not even out yet, but plenty of pilots had realised that this could be really hazardous and decided to do something about it. For themselves, their colleagues, everybody. Now that is double-loop learning.

Yet the accident revealed both the strengths and the weaknesses of how we learn in aviation. There had been trouble with radar altimeters on this kind of jet before. It turned out that some pilots in the same airline, as well as in other airlines, had sometimes experienced funny things with the radar altimeter. For example, spurious warnings about proximity to the ground would be triggered. In some cases, even the autothrottle would go into the wrong mode. But the failures would never repeat themselves on the next leg of the trip. They were impossible to recreate on the ground.

Also, on the accident flight, the jet was turned onto the localizer less then five miles before the runway and kept at 2000 feet, so it got stuck above the glideslope. When finally given clearance to descend with the ILS (which by then needed to be captured from above), the autothrottle retard made the airplane do exactly what the crew wanted: go down and slow down (which, in this jet, is really hard to do at the same time, by the way). The jet's behaviour masked the autothrottle retard problem until it was too late for the crew to recover.

It turned out that at this airport, tight line-ups are very normal. In fact, compared to some approaches even that very morning, the accident aircraft got a relatively long final. The official rules and guidelines for ILS approaches by the ANSP had not been followed for more than a decade (deviance was normal). Never mind the 5-mile minimum line-up. We do it everyday. It's the way we teach it. It's called a job and pilots appreciate us doing it.

But if an unknown is unknown, or the deviant has become normal, then the symptoms of trouble may go unrecognised. Hey, they landed without incident, right? No harm, no incident. At best, as a pilot you sit in the crew bus after the flight and say, "Boy, that final was a little tight today, wasn't it?" But if there is no close call, there is no report from anyone.

This is one of the biggest challenges for learning in aviation: how do we decide what counts as bad news? Learning after nine people are dead is one thing, but what is "near" enough to a bad outcome to count as a close call, as something that should be reported? People are expert at adapting their readings of risk so as to make the world look more normal, less hazardous. Norms for what counts as risky get renegotiated the whole time, particularly as operational experience with a procedure accumulates. Base to a three and a half-mile final for a 747? No problem, we do it all the time. And if he can do it, a four-mile final for a 737 should be a piece of cake. It is called production at this airport. It is, however, the kind of normalisation of deviance ("oh, we've seen this before, it's OK.") that eventually brings an unsuspecting jet with a funky radio altimeter down before the runway, rather than on it.

All the data from the accident in question here are from the official published accident report only.

See http://www.skybrary.aero/bookshelf/books/1175.pdf

Responses and comments from experts

[1] A formal response from ATC The Netherlands

by Job Brüggen, Safety Manager

Sidney's account addresses a well known aspect which is called "drift into failure". By absence of any mishaps the ongoing activities are declared as safe and risk barriers can slowly erode. If we are not constantly and credibly reminded of hazards, we tend to think the hazard is non-existent. Sidney's account nicely paints the picture for this with his bus ride at the airport where the crew decides not to file an ASR about a particular short line-up. The accident of a 737-800 that crashed on final approach because of lack of airspeed serves as a sad reminder of how many small contributions can turn an otherwise normal flight into a tragedy. The full report about this from the Accident Investigation Board (AIB) is publicly available .

The flight was a Line Flight Under Supervision with the Captain acting as instructor, the First officer acting under supervision and a third pilot acting as safety pilot. Whilst the AIB report about the accident is a long account of what happened, the report does little to help understand the behaviour in the cockpit. The captain actively calls "one thousand", as audible proof that he was indeed monitoring the altitude, yet it is not understood why he does not command a missed approach as the aircraft is not in a stable approach. Maybe he thought things would be working out okay? Not unlikely: at 1000 ft the autopilot was nicely tracking the glide slope and localizer, he had set the right speed on the autothrottle and although a little fast still, he may have expected the aircraft to settle on this reference speed. But at 500 ft, 33 knots (!) below his reference speed, with an unusual nose-up attitude, elevator trim visibly and audibly running to compensate, thrust levers at full retard, speed tape flashing, there can be little doubt about being in a non-stable approach. Thanks to the investigation report, we are made aware of how a technical failure in the aircraft, combined with a lack of awareness by the crew, joins up with an approach that puts the aircraft above the glide slope, which in turn partly masks the technical failure of the aircraft. But why were these experienced captains and two colleague pilots not responding to this (in hindsight) obvious threat?

This question mark is so enormous that, in absence of any suitable explanations, one may feel compelled to look for other clarifications. Here is where Sidney suggestively redresses the contributing factors in this accident as primary causes and without wanting to downplay the contributing factors of course, it is better to refer to the accident report: the principal cause of the crash was lack of airspeed on approach and subsequent stall.

Evidently, this aspect has been picked up by some airlines as shown by Sidney's simulator ride and put this aspect into their training programs. This seems a good and reasonable response to otherwise unexplained events. Although airlines cannot possibly fully understand what happened: better safe than sorry.

On the navigation support side, the ANSP is now undertaking renewed research into 'stabilised approaches' and the contributing role of the ANSP to achieve this. A stabilised approach is an important enabler to achieve consistently safe landings. Not without reason, this is a crucial requirement within all IOSA registered airlines. Efforts are underway to analyze how the ANSP can further support this requirement by putting in extra safety barriers and make another small step towards even better achievement of stabilised approaches.

[2] Comment from a Pilot perspective

by Captain Ed Pooley

Usually I enjoy reading Professor Dekker's human factors take on flying commercial aircraft. However, following an advanced opportunity to read his column this time, I offer what I believe is a more realistic examination of the pre-crash sequence.

If we forget for a moment the minor initiating malfunction of a radio altimeter, and that it had a long and not too illustrious history, we are left with a complete failure by any of the three flight crew to individually notice that the aircraft was attempting to stay airborne with idle thrust set. Since none of them noticed as individuals, CRM was not going to be relevant. So what did they all apparently not notice over a significant period on an undemanding Cat 1 ILS approach being flown to a non-limiting runway? Well, two things really stand out. Firstly, idle N1 (thrust), idle fuel flow and a steadily decreasing indicated airspeed must all, yes all, not have been 'noticed'. Secondly, the most abnormal aircraft attitude which began to develop as the aircraft tried to stay on the ILS glide slope with only idle thrust and the usual drag items (landing gear, trailing edge flaps) deployed, could not have been noticed either. Despite this drift into failure, the situation was still recoverable even when the stick shaker activated, if the response had been timely - but unfortunately it wasn't.

I will briefly return to the radio altimeter failure. Even without a history of malfunction on the accident aircraft being unrecorded and improperly dealt with, the radio altimeter has always been recognised as an instrument which, if it malfunctions, is probably going to affect other systems too. The fact that the failed system fed the auto throttle should have been readily within the possibilities reviewed by the crew, even if they were not specifically alerted to it by reading a specific

QRH drill. And besides, a design which normally links the left hand radio altimeter to the single auto throttle is entirely intuitive, as is the linking of each autopilot to its corresponding radio altimeter.

It is also worth observing that this was a line training flight for the First officer and a Safety Pilot was occupying the supernumerary crew seat and this should have lessened the chances of a prolonged failure to recognise that the aircraft energy state was not sustainable. Three pairs of eyes, including a pair of trainee's eyes, are usually thought to at least restore the margin of safety to the normal case of two fully qualified pilots.

Indeed, the short turn on and closure of the ILS glide slope from above may not be ideal, but it is well within the world of reality. Let's not forget that any pilot must be ready to decline any clearance which they believe will lead to an undesirable safety-related outcome.

> Let's not forget that any pilot must be ready to decline any clearance which they believe will lead to an undesirable safety-related outcome.

None of this interferes with the theme of 'inevitability' which comes across in Professor Dekker's piece which is over-focused on the role of the initiating radio altimeter malfunction (which the crew were aware of) and provides, at best, a rather idiosyncratic view of the descent into disaster and at worst, a rather irrational one. I will close by quoting from the Official Report :

"When the aircraft passed 1000 ft height, the approach was not stabilised so the crew should have initiated a go around… As the airspeed continued to drop, the aircraft's pitch attitude kept increasing. The crew failed to recognise the airspeed decay and the pitch increase until the moment the stick shaker was activated. Subsequently the approach to stall recovery procedure was not executed properly, causing the aircraft to stall and crash." It was also noted that "despite the indications in the cockpit, the cockpit crew did not notice the too big decrease in airspeed until the approach to stall warning. With the cockpit crew - including the safety pilot - working to complete the landing checklist, no one was focusing on the primary task: monitoring the flight path and the airspeed of the aircraft. It can thus (also) be concluded that the system based around the presence of a safety pilot on board….did not function effectively".

[3] Comment from an ATCO perspective

by Bert Ruitenberg

On the plus side, there is nothing in the text that is not addressed in the official report (albeit in other words). On the minus side, I think Sidney is too easily accepting statements from the report with respect to what is the "normal" way of working at EHAM.

The line up given to the accident aircraft was never an intentional "short line up". It just ended up intercepting the LLZ a mile closer to touchdown than expected - which may be a result of the timing of the turn-to-intercept instruction, or of the turn rate applied by the pilots, or a combination of the two.

For a "short line up" an aircraft at EHAM is normally vectored for an interception even closer to touchdown (4.5 to 5 NM) and given descent to 1200ft after passing the CTR boundary. Some aircraft were given such an approach that morning, but not the accident aircraft. The preceding aircraft was a Heavy, after which a 5NM minimal separation is required, and that is not a situation in which a controller will consider a "short line up" for the next aircraft in a busy sequence. (And yes, the report confirms that the 5NM wake turbulence separation minimum was not breached with the accident aircraft.)

What I accept to be correct in Sidney's text is that at EHAM, the controllers have drifted into believing that vectoring aircraft to intercept the LLZ close to the GP interception point is normal, rather than giving them a 2NM level flight on the LLZ before the GP comes in (as is stated in the procedures). This "modified" interception point however is more or less the position that pilots fly to themselves when they are cleared for a "do it yourself" ILS interception. Furthermore, pilots (when asked) often indicate that "a 6NM final is "sufficient", so controllers have adapted their vectoring accordingly over the years. I suppose a psychologist could rightly call this "normalisation of deviance".

In the simulator Sidney quickly detected the anomaly between the two automated systems, yet in the accident aircraft three pilots sadly did not respond timely to similar clues on the flight deck. Not reacting to anomalous calls and signals from a radar altimeter "because it does that all the time" is I guess another example of "normalisation of deviance".

In my opinion, the real message from Sidney's text is that both controllers and pilots need a more comprehensive understanding of the importance of stabilised approaches.

Do runway excursion accidents necessarily have precursors in lesser events?

By Captain Ed Pooley

It is generally considered that one of the ways to reduce the prospect of a serious incident or an accident is to ensure that careful attention is paid to all the lesser events[1]...

Captain Ed Pooley

is an experienced airline pilot who for many years also held the post of Head of Safety for a large short haul airline operation.

He now works as an independent air safety adviser for a range of clients and is currently acting as Validation Manager for SKYbrary.

The contributory factors which are identified in these lesser events usually involve potential precursors[2] of similar events, including accidents. It is also sometimes claimed 'in reverse' that accident investigations will invariably find that significant elements of the cause of an accident had visible and direct precursors in events with less serious outcomes. This model gives a heavy weight to the identification of precursors in lesser events as a means to accident prevention.

But is this always true? I am now going to take a look at one serious runway excursion that happened a couple of years ago in Denver, USA. Based on what the NTSB investigation[3] found had occurred and what was considered to have led to it, could this fortunately non-fatal, but nevertheless major, runway excursion have been foreseen on the basis of past experience of lesser events at either the airline or the airport concerned?

The accident occurred when the pilot handling the initially uneventful night take off of a Continental Airlines Boeing 737-500 (the Captain) lost control near to rotation speed on a take off on gusty crosswinds. The aircraft left the runway and careered over 700 metres across mainly flat ground before coming to a stop. Fortunately, all the occupants escaped before a fuel fed fire turned the aircraft into a convincing hull loss. The result is shown in the photograph taken from the official accident report.

Photograph taken from the official accident report

1- I define a 'lesser event' as one which excludes a 'Serious Incident' which ICAO define as one where an accident nearly occurred and prescribe an independent investigation under the same Annex 13 procedures as apply to the investigation of actual accidents.

2- A Precursor is "a thing that comes before another of the same kind" (OED)

3- http://www.skybrary.aero/index.php/B735,_Denver_USA,_2008_(WX_HF_RE_FIRE)

The precise wind velocity to which an aircraft was actually exposed can only be discovered by referring to the aircraft flight data recorder after a flight. There is no readout of it on the flight deck.

There are a couple of interesting things about Denver (apart from the unusual design of the main terminal building) that some readers may be aware of. The first is that it is situated at an abnormally high altitude for a major commercial airport of over 5000 ft amsl and the second is that it is well known to be subject to mountain wave conditions as a result of its proximity to the Rocky Mountains. Although the first has a significant effect on aircraft take off and landing performance, it had no relevance to the accident we are looking at – the aircraft was about to get airborne about half way down the runway. The second, however, is the cause of 'interesting' wind velocity variations at Denver and has led to the setting up of one of the most comprehensive integrated systems for the tactical measurement of low level wind velocity in the world. ATC see summaries of this and other information as well as hear any pilot reports and are then faced with the decision of how best to give pilots useful information when they are about to make a take off or landing.

Let's look briefly at the matter of maintaining directional control of an aircraft in strong and variable crosswinds.

Although not all aircraft manufacturers stipulate a maximum crosswind component permitted during a take off or a landing in a particular type (Boeing did not do so for any of their aircraft types at the time of this accident), such limits are likely to be included under 'Limitations' in the applicable Operations` Manual current at the time and the figures for take off and landing may be slightly different. The question of whether it is probable that any take off or landing can be made without exceeding those limits is not a matter of measurement. The precise wind velocity to which an aircraft was actually exposed can only be discovered by referring to the aircraft flight data recorder after a flight. There is no readout of it on the flight deck. So what the pilot normally expects is to receive from ATC, by ATIS or directly, the available and relevant information about the actual wind velocity which has been recorded in the general vicinity of the runway concerned in the past few minutes. They will be aware that in gusty conditions, a change in the 'spot' wind speed can be expected to be associated with a simultaneous change in the exact wind direction (and that in the northern hemisphere, the instantaneous wind direction can be expected to back if the speed increases and veer if the speed decreases). Most pilots will be aware that there are formalised requirements to declare the range of wind directions and wind speeds either side of the mean, once either exceeds an officially specified threshold of variation. They will be grateful for ATC services which pre-empt their questions about wind velocity variation, but ready to ask for what has not been offered already and, in the context of what they know, is needed to complete the picture.

What about ATC and the information they pass on about the wind? It will not be the wind velocity where the aircraft actually is or is soon going to be. Instead, it will be a modest selection of the most useful data which will inform the decision of whether the imminent landing or take off should be executed. Most ATC TWR Units are good at ensuring that the pilot has the best available information. Some tend to respond to requests from the pilot but many do not wait to be asked but proactively offer what they have and keep it updated until the actual take off or landing is in progress. ▸

Do runway excursion accidents necessarily have precursors in less serious events (cont'd)

The investigation into the Denver accident found that the probable cause of the accident was:

"The Captain's cessation of right rudder input, which was needed to maintain directional control of the airplane, about 4 seconds before the excursion, when the airplane encountered a strong and gusty crosswind that exceeded the Captain's training and experience."

It also established that:

"Performance calculations indicated that the airplane's rudder was capable of producing enough aerodynamic force to offset the weathervaning tendency created by the winds the airplane encountered during the accident takeoff roll".

In other words, the (unanticipated) wind velocity conditions encountered exceeded the ability of the pilot involved on the day but not the capabilities of the aircraft. Despite the fact that the actual (momentary) crosswind component at the point where control was lost was estimated to have been at least 10 knots greater than the applicable Operations Manual limitation. It was observed in the probable cause statement that the specific training and experience of the pilot had not exposed him to a comparable challenge in the past and that, by implication, this had increased the likelihood of the handling error which directly led to the accident.

The investigation concluded that the main way forward regarding flight crew skills was to use a higher fidelity training simulator , so that pilots could be exposed during training to the full range of anomalous surface wind velocity conditions which they may possibly experience, even if only very rarely. With regard to the performance of the flight crew, no precursor from a lesser events was found for this accident, only that it had occurred in the context of insufficient training for circumstances which, in detail, were always going to be rare.

The investigation also noted that:

(1) "Mountain wave conditions were present at the time of the accident and resulted in strong westerly winds and very localized, intermittent wind gusts as high as 45 knots that crossed the airplane's path during the takeoff ground roll".

(2) The TWR ATCO "did not….provide information about the most adverse crosswind conditions that were displayed on his ribbon display terminal; therefore, the pilots were not aware of the high winds that they would encounter during the takeoff roll."

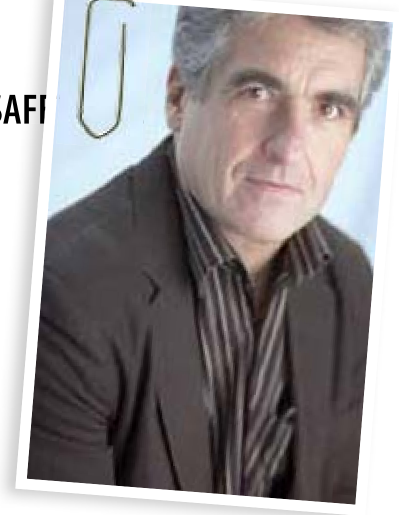
(3) "Other airplanes departed on runways 34L and 34R before the accident pilots' departure; the pilots of those departing airplanes did not report any crosswind-related issues or difficulties"

(4) "Currently, the Denver International Airport air traffic control tower runway selection policy does not clearly account for crosswind components when selecting a runway configuration".

Although there was no general evidence of especially challenging crosswind conditions at the time, ATC did not pass the accident aircraft all the potentially useful information on wind velocity which they had access to. Of course if there are procedures to guide the designation if active runways, then they must take proper account of likely crosswind components. Those at Denver did not. Furthermore, if there are procedures to guide the selection and transmission of observed wind velocities to aircraft about to land or take off, then these must guide controllers on the optimum selection of wind velocity data to be given to a pilot. Those at Denver did not. The recommendations provided procedural fixes to both issues but again no specific precursors were identified in any previous lesser events.

The (unanticipated) wind velocity conditions encountered exceeded the ability of the pilot involved on the day but not the capabilities of the aircraft.

The simple fact is that a take off successfully accomplished in challenging crosswind conditions leaves no trace. In such an accident, there were never going to be any Aircraft Operator or ATC precursors in lesser events and so in this example at least, the case is made. I would suggest that it invites a deeper review of how we can enhance accident prevention without relying so heavily on the database of lesser events to inform risk assessment. But that's for another time…and it is not in any way a general argument for not seeking to collect data on lesser events, for which there are many other sound justifications.



Hello,

My name is Richard "Sid" Lawrence and I would like to introduce myself as the new face of the EUROCONTROL Safety Alert service.

I joined EUROCONTROL in 2006 having served in the UK Royal Air Force as an air traffic controller at home and abroad in a career spanning 29 years. Since arriving in Brussels, I have worked as a coordinator for the European Safety Programme for ATM (ESP) covering a wide range of ATM safety-related issues. As well as my work coordinating EUROCONTROL Safety Alerts, I am also the EUROCONTROL Call Sign Similarity Project Manager.

Regular readers will know that a selection of the latest Safety Alerts is featured in this magazine. I'm pleased to continue with this convention. In the pages that follow, my aim is to take you through the Alerts that are of interest to you. Unlike in the past when the emphasis was on a faithful reproduction of the Alerts, my intention is to try and bring new information to the table. So this section will feature more in the way of feedback, responses, comment and analysis related to each Alert.

If you would like to know more about the EUROCONTROL Safety Alert service, register as a subscriber, submit a suggestion or have a subject that you wish to consider for a Safety Alert then please contact me at ***richard.lawrence@eurocontrol.int.***

The first Safety alert to be reviewed is a Request for Support Message - IFR Aircraft Operations Below RVR Minima...

REQUEST FOR SUPPORT MESSAGE

IFR Aircraft Operations Below RVR Minima

Published 15 March 2010

Synopsis

It has been reported that in one European state, aircraft sometimes approach and land despite the reported RVR at the destination aerodrome being lower than the applicable minima for approaches/landing given in EU OPS 1, Appendix 1(Old) to OPS 1.430.

The purpose of the Request for Support message was to invite air navigation service providers and aircraft operators to share their experiences and good practices related to the topic.

Analysis

The conduct of Low Visibility Operations is detailed in EU Ops 1. The State in question had not established and published the lowest aerodrome operating minima for its aerodromes - EU OPS 1, OPS 1.430 only says that, "…Such minima shall not be lower than any that may be established for such aerodromes by the State."

Consequently, its air traffic controllers are not aware of such limitations i.e. that for each instrument approach at a particular aerodrome there is a minima which no operator should go below. Furthermore, the controllers do not have in place a procedure(s) to act as a 'safety check' when a commander decides to commence an approach to land when the reported RVR is less than the specified Minima.

UK CAA/NATS AIC 100/2006 provides details of how the UK applies the concept of 'Absolute Minima RVR' for certain types of operations.

Assumptions

- Controllers are not permitted to prohibit a pilot from making an instrument approach other than for traffic reasons. The final decision to commence an approach in specific weather conditions rests solely with the commander of the aircraft.
- Controllers are not responsible for determining, passing or enforcing commanders' mandatory aerodrome operating minima.

Alternatively, register your interest through the EUROCONTROL Website - Safety Alerts Board ***http://www.eurocontrol.int/safety/public/standard_page/safety_alert_board.html*** *or go to SKYbrary:* ***http://www.skybrary.aero/index.php/Portal:EUROCONTROL_Safety_Alerts*** *to access the Alerts featured here and all previous Alerts.*

Support requested

ANSPs and aircraft operators were invited to respond to the following questions:

- What should controllers do when a commander indicates that he/she intends to commence an approach when the reported RVR is below the lowest minima for that aerodrome/approach?
- What are your practices in dealing with this issue (can also apply to take-off)?

Additional Considerations:

The following considerations could inform responses:

- The need for States to establish and publish RVR Minima for all instrument approach procedures at aerodromes.
- The requirements for controller awareness and training regarding RVR Minima.
- Controller responsibility/authorisation regarding the issuing of landing clearance when the reported RVR is below the RVR Minima.
- The need for controller procedures and associated phraseology.
- The requirements for controller reporting of LVO related occurrences.

Feedback and responses

A total of 24 responses were received: 8 from ANSPs, 13 from Aircraft Operators/Associations and 3 from National/Regulatory Aviation Authorities. The responses also included detailed extracts from one national AIPs and one Aircraft Operator's operations manual dealing with RVR Minima.

All respondents to the RFS agreed that the Assumptions in the RFS were correct. It is clear that the division of responsibility between the cockpit and control room is well understood.

There was unanimous agreement amongst the aircraft operator respondents that the controller's responsibilities vis-a-vis the decision of a pilot to continue an approach (or take-off) should be limited to providing the RVR values and ensuring that the runway surface is clear of obstructions.

A similar understanding is apparent from the responses from the ANSPs: i.e controllers are only obliged to pass the weather information, ensure the runway is clear and then carry on controlling as normal. The view was also shared by two National Aviation Authorities:

With specific regards to RVR minima it was also clear to respondents that this is the responsibility for Aircraft Operators and pilots and not ATC. Notwithstanding this, one ANSP has introduced a warning to be broadcast on ATIS during Low Vis Ops: "Attention, crews of arriving traffic, check your landing minima." Whilst another ANSP respondent stated that perhaps ATC should remind pilots to "remember [check] your minima".

Landing Clearances

With regard to the responsibility (and possible liability) of controllers issuing landing clearances to aircraft they know (or suspect) are operating below any established RVR minima, there were mixed responses. In some cases it was suggested that ATC should offer conditional or discretionary clearances: e.g. "clear to land at own discretion".

Whilst others state that in line with the principle that it is ultimately the aircraft commander's responsibility, the controller should issue a normal landing clearance providing the runway is clear and traffic permits:

EUROCONTROL notes:

This theme is taken forward in ICAO PANS ATM 7.10.2. which states, "An aircraft may be cleared to land when there is reasonable assurance that the separation in 7.10.1, or prescribed in accordance with 7.11 will exist when the aircraft crosses the runway threshold…"

It is important to recognise that an ATC clearance to land is not an instruction. As described in PANS ATM 4.5.1., "Clearances are issued solely for expediting and separating air traffic and are based on known traffic conditions which affect safety in aircraft operations". In the case of a landing clearance this means that the controller has taken the necessary actions to ensure that the runway is clear and that safe separation can be maintained from other traffic. The pilot is not bound to comply with the clearance (if for instance the weather conditions prevent a landing) but should inform the controller if they do not intend or cannot execute it.

Moreover, ICAO PANS ATM, 4.5.1.3, clearly identifies where the division of responsibility/accountability is between ATC and the pilot-in-command regarding the execution of issued ATC clearances. [EUROCONTROL emphasis in bold and underline text]

- *"4.5.1.3 The issuance of air traffic control clearances by air traffic control units constitutes authority for an aircraft to proceed only in so far as known air traffic is concerned. ATC clearances do not constitute authority to violate any applicable regulations for promoting the safety of flight operations or for any other purpose;* <u>**neither do clearances relieve a pilot-in-command of any responsibility whatsoever in connection with a possible violation of applicable rules and regulations."**</u>

Thus, there should be no need for controllers to issue discretionary type landing clearances. Controllers can issue a normal landing clearance once they have fulfilled their safety and traffic responsibilities – the decision to execute that clearance is solely the pilot-in-command's taking into account, inter alia, any minima (including RVR) that are applicable.

The complete Summary of Responses can be found on the SKYbrary Bookshelf.

SAFETY WARNING MESSAGE

Emergency descent in high traffic density situations

Published 22 July 2010

Purpose

The Safety Warning Message was raised to highlight the concerns of European aviation stakeholders related to 'emergency descent', in particular in high traffic density scenarios.

Synopsis

Existing ICAO provisions describe what is expected from air traffic controllers and pilots in the event of an emergency descent, including the option for ATC to broadcast message regarding the emergency descent. However, the provisions may, in some circumstances specific to high density operations, lead to potential risks for operations and several European States have therefore promulgated different national procedures to be followed.

ICAO Provisions

According to ICAO PANS ATM, § 15.1.4: "Upon receipt of advice that an aircraft is making an emergency descent through other traffic, all possible action shall be taken immediately to safeguard all aircraft concerned. When deemed necessary, air traffic control units shall immediately broadcast … … an emergency message."

PANS ATM, § 12.3.2.5 specifies the emergency message phraseology: "ATTENTION ALL AIRCRAFT IN THE VICINITY OF [or AT] (significant point or location) EMERGENCY DESCENT IN PROGRESS FROM (level) (followed as necessary by specific instructions, clearances, traffic information, etc.)"

With regard to the actions by the pilots-in-command (PIC), PANS ATM § 15.1.4.2 states: "It is expected that aircraft receiving such a broadcast will clear the specified areas and stand by on the appropriate radio frequency for further clearances from the air traffic control unit."

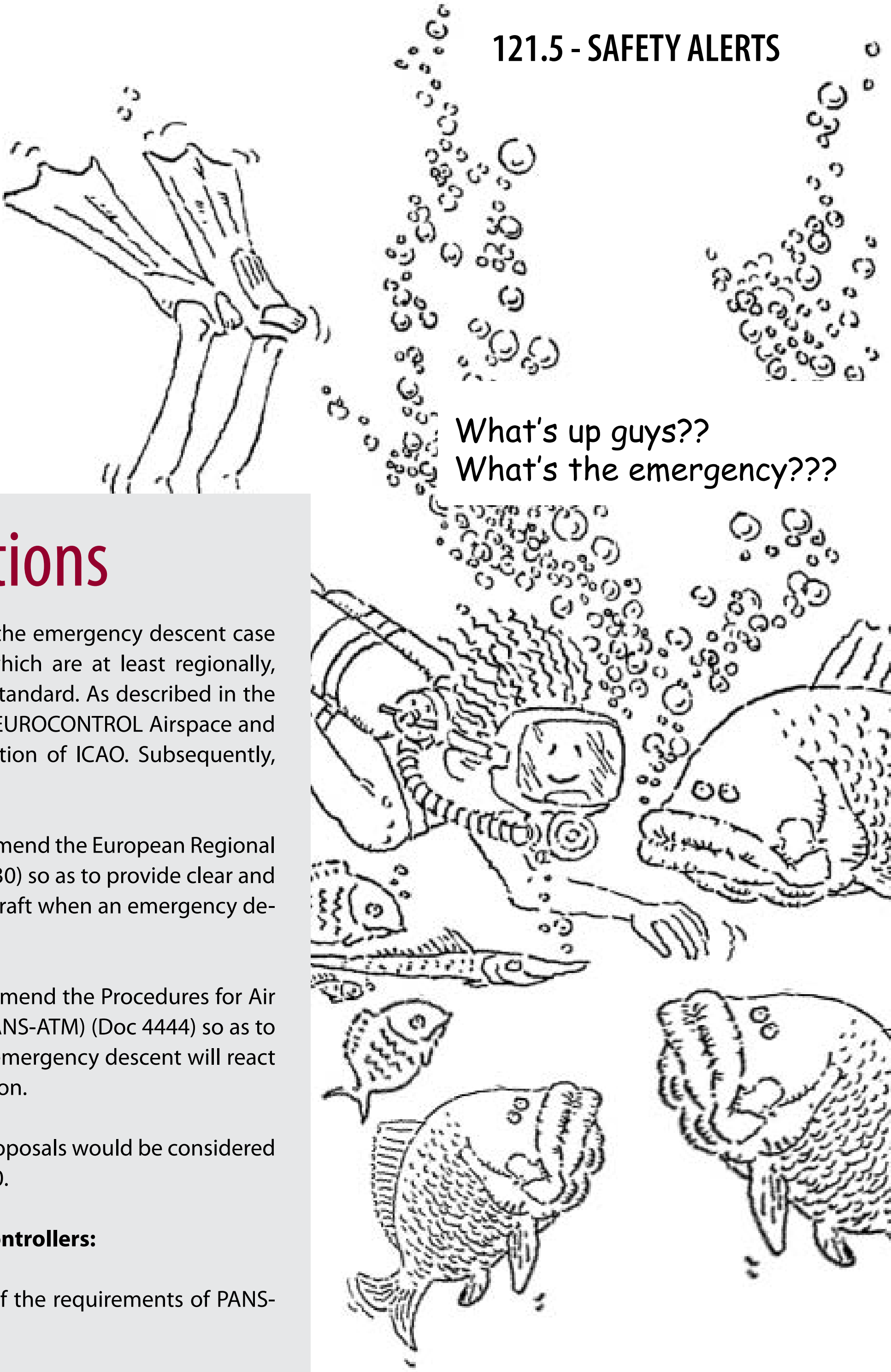
In addition, the provision 9.1.1.1 of the European Regional Supplementary Procedures, ICAO Doc. 7030, recommends pilots of the aircraft executing an emergency descent to "…initiate a turn away from the assigned route or track before commencing the emergency descent"

Analysis

A broadcast of a message associated with emergency descent is optional and depends on the best judgement of ATC in a given set of circumstances. However, the pilot community expressed a need to be informed of such events especially with regard to ACAS TAs/RAs that may be experienced when they are in close proximity to aircraft conducting an emergency descent.

An emergency message broadcast would also be received by aircraft not necessarily affected by the emergency descent. Therefore, unless the emergency broadcast is appropriately targeted and contains unambiguous instructions, there is the possibility of aircraft unexpectedly deviating from their track to 'clear the specified area' which, in areas of high traffic density, has the potential to create additional hazardous situations.

In mitigation, several ATS authorities and ANSPs in the EUR Region have published in their national AIPs, procedures indicating clearly that an aircraft receiving an emergency broadcast is not expected to leave the specified area, but is to continue according to their latest clearance unless threatened by immediate danger, and to stand by on the appropriate channels for specific clearances and instructions.



Emerging considerations

It is considered that effective risk management of the emergency descent case in controlled airspace requires ATM procedures which are at least regionally, and preferably internationally, defined to a single standard. As described in the original SWM the matter is under active review by EUROCONTROL Airspace and Navigation Team in association with the ATM Section of ICAO. Subsequently, EUROCONTROL has been invited to:

- Develop, as a short term solution, a proposal to amend the European Regional Supplementary Procedures (EUR SUPPs) (Doc 7030) so as to provide clear and concise direction to air traffic services and to aircraft when an emergency descent is in progress.

- Develop, as a long term solution, a proposal to amend the Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM) (Doc 4444) so as to minimise the chance that aircraft notified of an emergency descent will react in a manner that could create a hazardous situation.

At the time of writing, it was anticipated that any proposals would be considered by the EANPG COG at its meeting in November 2010.

In the meantime, it is suggested that air traffic controllers:

- Note the potential pilot actions stemming out of the requirements of PANS-ATM § 15.1.4. 2.

- Where practicable, try to provide specific instructions to those aircraft that would be in direct conflict with the emergency descent aircraft, when it is judged necessary to broadcast an emergency message.

- Follow national procedures where these are published.

Further Actions and Considerations for ATC can be found in the SKYbrary article 'Emergency Descent: Guidance for Controllers' at http://www.skybrary.aero/index.php/Emergency_Descent:_Guidance_for_Controllers

This article also contains links to other training materials:

- EUROCONTROL Guidelines for Controller Training in the Handling of Emergency/Unusual Situations
- Unexpected Events Training

SAFETY REMINDER MESSAGE

Abbreviation and Misinterpretation of 'Type C' R/T Call Signs

Published 5 August 2010

Synopsis

The EUROCONTROL Call Sign Management Cell (CSMC) had received a number of reports of call sign confusion caused by the incorrect abbreviation or misinterpretation of some 'Type C" R/T call signs whose alphanumeric flight identification suffixes start with a zero.

ICAO provisions

ICAO Annex 10, Vol II, Chapter 5, § 5.2.1.7.2.2 states that there is no abbreviated form for "Type C" call signs (i.e. those that are formed by the R/T designator of the aircraft operating agency (e.g. 'Highjet'), followed by the flight identification suffix (e.g. '123A')).

Analysis

In the occurrences that have been reported, the flight identification suffix of the call sign was alphanumeric and had a 'leading zero', e.g. Highjet 045K. These flight identifiers have sometimes been incorrectly abbreviated, e.g. Highjet 45K, or have been misspoken as Highjet 405K, which has contributed to some crews becoming confused about which flight is being addressed by ATC.

Feedback and discussion

- There is no standard policy amongst the airlines on use of leading zeros. Most, however, try not to use them whereas others are more inclined to utilise them if it helps with their commercial flt number allocation or ATC call sign de-confliction.

- From the available literature on the subject of avoiding call sign similarity/confusion these additional points (not exhaustive) are worth bearing in mind:
  - Wherever possible try to use no more than 3 digits in the call sign suffix.
  - Start the call sign suffix with higher number, e.g. 6.
  - In accordance with ICAO Doc 8585, try not to create call sign suffixes ending with a zero (or a 5) to avoid potential confusions with headings, flt levels etc.

- The EUROCONTROL Call Sign Similarity Project launched in 2008 aims to reduce the risks associated with Call Sign Similarity/Confusion through the establishment of centralised and co-ordinated actions based around a CSS Tool and Service managed by the EUROCONTROL Central Flow Management Unit, Call Sign Management Cell.

- For more information on the EUROCONTROL Call Sign Similarity Project please go to http://www.eurocontrol.int/safety/public/standard_page/Callsign_Similarity_project.html

- or the Call Sign Similarity Management Cell - http://www.cfmu.eurocontrol.int/cfmu/public/standard_page/cfmu_programmes_css.html

Further reading

- ICAO Annex 10, Volume II Chapter 5.
- SKYbrary - Air Ground Communication Briefing Note No2 www.skybrary.aero/bookshelf/books/110.pdf

REQUEST FOR SUPPORT MESSAGE

Briefing and Provision of Operational Aeronautical Information to Air Traffic Controllers

Published 20 August 2010

Purpose

The purpose of this Request for Support message (RFS) was to gather good/best practices associated with the briefing and provision of operational aeronautical information to air traffic controllers, both before and after they assume responsibility for a particular control position.

Synopsis

A European ANSP has received safety reports regarding a lack of operational information (e.g. NOTAM, airspace/procedure changes etc) available at controller working positions (CWP). The ANSP was conscious that it perhaps could adopt the 'good/best' practices used by other ANSPs and it is hoped that the feedback information will help them in their quest to improve their processes/facilities in due course.

ICAO provisions

Other than some very generic advice in ICAO Doc 9426, ATS Planning, there are no other known specific requirements/standards related to the type and format of the aeronautical information that should be displayed to controllers when they are at their operating positions.

Analysis

The timely and accurate presentation of operational aeronautical information is clearly safety related. ATCOs need access to it to permit them to assess situations and adjust their controlling actions accordingly. The specific briefing actions that should be taken at each unit and at each operating position vary according to local ANSP needs.

Support requested

Air navigation service providers were asked to provide brief details of how they disseminate operational aeronautical information to ATCOs and in particular if this is delivered/accessed via electronic self-briefing facilities and/or is presented in electronic format to controllers at CWP.

Feedback and discussion

A total of 18 responses were received: 14 from ANSPs, 2 from ATC Associations, and 2 from aircraft operators.

As anticipated, it was evident from the replies from ANSPs that a variety of methods are used to brief controllers prior to their undertaking operational control tasks. These include:

- Verbal briefing by Supervisor/manager. Military ANSP includes aircrew.
- Electronic self-briefing
- Email, internet
- Written documentation (AIP AMDTs, NOTAMs etc)/Checklists/Information folders/Staff Notices etc

For the provision of operational safety-related aeronautical information at controller working positions (CWP) there was again a mixed-bag of responses:

- Electronic Support Information Retrieval type systems
- Paper NOTAMs (Note: One ANSP had recommended that details of certain activities (e.g. gliding areas) that are defined by list of coordinates should also be made available to controllers at their CWP in graphical as well as written/text form.
- Supervisor support.

SAFETY REMINDER MESSAGE

Operation of SSR Mode C by General Aviation VFR Recreational Flights

Published 13 October 2010

Synopsis

A European ANSP requested that pilots of General Aviation (GA) VFR recreational flights are reminded of the positive safety effects that the operation of SSR Mode C (when fitted) offers themselves, other airspace users and ATC/FIS providers.

Guidance on the operation of SSR Mode C

Guidance on the operation of SSR Mode C is covered, inter alia, in:

- ICAO Doc 8168, PANS OPS Vol I, 1.1.3;
- European General Aviation Safety Team (EGAST) Collision Avoidance Safety Promotion Leaflet (GA1);
- EUROCONTROL Guidance Notes for GA Pilots, No 11, 'Getting the Most from Your Transponder';
- National AIPs which in some states mandates the operation of Mode C (and in some cases Mode S) when flying VFR outside CAS.

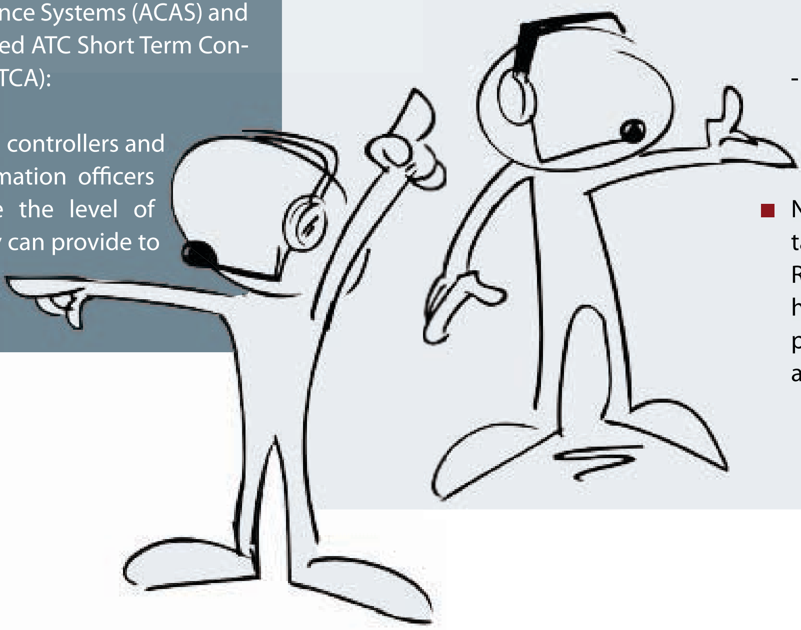
Analysis

Notwithstanding any local differences notified in National AIPs for the carriage and operation of transponsders, it is generally recognised that, when fitted and operated, the use of Mode C (verified or un-verified), provides the following safety benefits:

- It preserves the full effectiveness of Safety Nets such as Airborne Collision Avoidance Systems (ACAS) and ground-based ATC Short Term Conflict Alert (STCA):
- It also helps controllers and flight information officers to enhance the level of service they can provide to all users.

Feedback and discussion

Although only very limited feedback was received following publication, there was strong support for this message from a range of organisations (e.g. IATA and IFATCA) during the pre-release consultation process undertaken before the circulation of all Safety Alerts.



Further reading

- ICAO Doc 8168, PANS OPS Vol I.
- EGAST Collision Avoidance Safety Promotion Leaflet (GA1) - www.easa.europa.eu/essi/egastEN.html
- SKYbrary:
  - EUROCONTROL Guidance Notes for GA Pilots, No 11, "Getting the Most from your Transponder" - http://www.skybrary.aero/bookshelf/books/714.pdf
  - Safety Nets - http://www.skybrary.aero/index.php/Safety_Nets
- Netherlands AIC A01/10 – Importance of Selection of SSR Mode C Regarding Collision Avoidance. - http://www.eurocontrol.int/msa/public/standard_page/modes_aics_netherlands.html

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SAFETY WARNING MESSAGE

FANS CPDLC Erroneous ATC Log Data Presentation

Purpose

Published 22 July 2010

The purpose of the Safety Warning Message was to warn about incidents involving potential erroneous presentation of ATC LOG data to flight crew while in Oceanic FANS CPDLC operation.

Incident No1

A recent incident occurred where a (data link) message to climb may have been sent to an aircraft without the ANSP Oceanic Ground System initiating it. The crew had requested FL360 and they were then presented with a message giving them clearance to climb to FL360. However, the clearance message was one that had not been issued by the Oceanic Ground System and it is purely coincidental that the clearance came back for FL360. At the time of publication (June 2010), the airframe producer provided some initial advice to aircraft operators. However, following investigations by Airbus, this advice has been superseded and new information was posted on the Safety Alert and advertised via a SKYbrary Highlight in October 2010. This information is provided below.

"Based on the provided traces, no CPDLC Clearance to Climb was ever received on board the A330. In addition, all CPDLC Climbing Requests had been refused by the ATC "DUE TO TRAFFIC". Analysis of the traffic logs show that neither a jump in the ATC message sequence number, nor communications issues nor any reset of the FANS system occurred in flight.

There is no known issue of any "ghost" messages on the aircraft manufacturers FANS system. The standard ATC answer to a climb request is "CLIMB TO & MAINTAIN FLXXX". No such message was ever received on board.

To avoid any confusion between a clearance received and displayed on the dedicated screen (DCDU) upon reception and *an old clearance (already treated) that can be consulted on the MCDU (totally different from the DCDU) Message Record page, a training emphasis has been issued by the aircraft manufacturer (Airbus) to its customers. SOP amendments are currently considered in operational documentation (FCOM, QRH handbook). Further improvements are however being implemented in future FANS standards to avoid any confusion".*

Incident No2

The circumstances of incident No 1 are similar to those experienced last year involving the same ANSP and another major airframe producer. On that occasion, subsequent investigations found that if FMCs on some aircraft are not powered down fully after the aircraft has landed then, on very rare occasions, ATC messages have been retained by that unit and can appear on a later flight of that aircraft. Consequently, the ANSP was informed by the airframe producer that it had advised aircraft operators of this potential problem.

"We are aware of a problem where ATC LOG data from a preceding flight has been retained and later represented to the crew in the ATC LOG while in FANS CPDLC operation. The ATC LOG data is normally cleared ten (10) minutes after the FMS transitions to the DONE phase. However, certain conditions can result in message retention and display in a subsequent flight ATC LOG."

Moreover, the ANSP advised its controllers to be aware of this potential phenomenon particularly if questioned by crew in respect of unrequested changes of flight profile.

Feedback and discussion

This is a complex issue involving ANSPs, aircraft operators and aircraft manufacturers.

Following the investigation of Incident No 1, the occurrence was discussed by the ICAO North Atlantic Communications, Navigation and Surveillance (NAT CNSG) in September/October 2010. The Group noted that the investigation had not found any evidence to explain the unauthorised climb. Numerous bench tests and flight tests had been carried out to reproduce any undue display of wrong clearance.

The Group surmised that such problem reports should normally be analysed by the NAT Data Link Management Agency (DLMA) as it possessed the necessary expertise and tools in cooperation with the airframe manufacturers to analyse such cases.

Further reading

SKYbrary:

- CPDLC
- Automatic Dependent Surveillance

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See all EUROCONTROL Safety Alerts at either SKYbrary
http://www.skybrary.aero/index.php/Portal:EUROCONTROL_Safety_Alerts

or

The EUROCONTROL Website Safety Alerts Board
http://www.eurocontrol.int/safety/public/standard_page/safety_alert_board.html

STOP PRESS!

The Safety Alert section of HindSight 11, featured the Safety Reminder Message, Own Separation between IFR Flights in VMC and Interaction with ACASII Ops. Since then it has emerged that the State in question is in the process of revising its Rules of Air so that they will comply with ICAO PANS ATM § 5.9 provisions related to the self separation of IFR flights operating in VMC.

Case Study - Her new barbecue sauce

By Bengt Collin, EUROCONTROL

The Air Hostess

Welcome to Angel's Town, the local time is ten past two …the air hostess stopped talking. The announcement was interrupted by a loud and different sound; the aircraft began to move in an unfamiliar way as it finally stopped. She got out of her seat, nobody said anything; it was like time had stopped, like someone had pressed the pause button. Through the window to the right she could see the terminal building far away, suddenly the captain's voice came over the PA system, focused and clear "evacuate, unfasten seat belts, evacuate", a brief irritating noise followed the message and then the prerecorded message repeated what the captain had just said; they opened the doors and over wing emergency exits…

The Tower Controller

It had been a lovely summer evening until it started raining. The heavy shower hammered down noisily and all outside life looked miserable and very wet. With the visibility in all directions reduced, it was like mist. She did not really care, no arrivals nearby. Ten minutes later, as quickly as it had started raining, it stopped. Perhaps it was still possible to have a barbecue later, she wanted to test her new recipe for a barbecue sauce; olive oil, garlic, soya, black pepper, topped off with a large glass of Bailey's. Yum Yum! She planned to use the rest of the small bottle as a refresher while barbequing. After all you did not want to dry out completely, she thought and smiled.

Bengt Collin

works at EUROCONTROL HQ as an Senior Expert involved in operational ATC safety activities.

Bengt has a long background as Tower and Approach controller at Stockholm-Arlanda Airport, Sweden

The D-line Captain

They had been discussing the roster intently. "Why do I always have to sleep away from home on Friday nights?" the first officer complained.
"Someone has to do it" the captain replied. "I am always off on Fridays." 'Thank God it's Friday' is my motto," he laughed, but the first officer did not.
"Have you checked the weather?" the captain asked.
"Yep, 270/11 CAVOK +20. Perfect for barbecuing" the first officer replied.
"Should we ask for straight in runway 12?"
"We're a bit high but, OK, why not" replied the captain.

The Approach Controller

He was reading the morning paper even though this was not allowed when in position. He did not care, this was a widespread habit and no one complained. To the right of him worked Beate, a smart and good looking controller with a great sense of humour. "Do you know why Swedes can never become Formula 1 drivers?" she asked. "Because they return to the pit stop after each lap and ask for directions" she continued without waiting for his answer. She laughed - a bubbling but discrete laugh which he loved, and her jokes were brilliant too! After all, why spoil a great joke with the comment that Sweden actually had produced a number of good drivers - it did not seem important.

He did not really pay attention to the traffic on his screen. Instead, he started thinking about an article he had read somewhere the other day, an article on runway excursion. It obviously caused a number of fatalities each year; he did not know the magnitude of the problem, they never discussed it at work. Some pilots obviously could not land. He had some pilot experience of his own; he did five hours in a Piper Cherokee some ten years ago. Could it be so complicated to land an aircraft safely? He had been sent to a conference the other week to gather some information on the subject, but it was really disappointing. The subject was "Runway excursions – the way forward", but already in the opening speech the scope was reduced to "how to standardise the measurement of braking action". He could not understand why, as this was only one of many minor contributing factors all completely overshadowed by other more significant ones. One presentation after the other followed, sometimes briefly interrupted by comments from participating pilots. The minutes and summary were probably written before the meeting and everybody just had to stick to them. At the end of day two, the way forward was decided, on the way home he could not remember what the decision was.

Beate left for a coffee, two aircraft were inbound, a B-line a long distance away towards the South East, the other one a D-line arriving from the North West.

Runway 30 was in use with no departures scheduled for the next twenty minutes. It was difficult to decide who should be number one, probably the B-line but D-line was faster. He thought that it was always easier when the traffic is more intense to stop thinking and act on your instincts instead. Why not offer D-line a straight in Runway 12? That should solve the conflict between them. The standard culture when working on approach control included offering short cuts and diversions from standard routes. He was sure the flight crews liked it, not that he had talked to anybody about it, he just knew. "Is runway 12 available?" one of the flight crew at D-line suddenly asked, as if reading his mind. "Stand by" he answered and started to coordinate with the Tower Controller.

The Tower Controller

"Sure no problem, straight in runway 12 is approved. We have a few Cbs around but they shouldn't interfere with the final. I will fix a new met report soon, just so you know, only need to finish my late lunch first. My colleague just went down to buy a newspaper, have to do everything myself as usual" she laughed. "Are you having a barbecue tonight by the way? I have used a new sauce recipe if you're interested. Talk to you later" she finished the conversation without waiting for his answer and continued with her salad.

The D-line Captain

"OK perfect, straight in runway 12 will save us a lot of fuel. We're a bit high. Please ask approach if we could make a delaying turn to lose some height. I'll tell the passengers, the cabin crew need to hurry up, your controls."

The Approach Controller

He was just about to turn D-line for a long final runway 12 when one of the pilots asked for an extended routing. Why did they not think about that before, now there could be a conflict between the two flights approaching opposite ends of the runway. He approved the extra turn, waited and waited before turning D-line back towards final for Runway 12. The aircraft turned very slowly, reduced speed so much that it almost stopped. "Descend to 2000 feet and keep the speed up, you're number one". The aircraft would join final inside 6 miles from touch down but at least it would probably not be in conflict with B-line. D-line did increase the speed.

The Tower Controller

She finished her salad and sat down in front of the computer intending to write the new weather report. Following the heavy rain a few minutes ago she noticed that the wind had increased, it was now almost 20 knots from North West. She started typing but stopped. Better inform approach. She pressed the intercom button while she discretely held back an imminent and unexpected burp.

The Approach Controller

"Turn right heading 090, cleared approach runway 12."
"Tower wait I have traffic." The aircraft read back and turned towards five miles final. "Tower what did you say? OK I will give him the new wind. OK, thanks."
"D-line, the wind has increased, new wind 310 degrees 18 knots".

The D-line Captain

He turned right towards final for Runway 12, they were still well above the glide path, with gear down and flaps 3 selected. The speed was still too high, flaps all the way he requested; and take care of the EGPWS warning he quickly added in a friendly way. The Approach Controller called, the wind had increased; no problem he told the first officer, I landed here before you were born, the runway is long enough. They continued the approach, were told to contact the Tower and got visual contact with the runway straight ahead, how he loved coming home to Angel's town. Passing 500 feet the aircraft was still not properly stabilised but he had full control and had been cleared to land with speed OK. Passing the threshold, twenty, ten, the metallic voice was too loud he thought, still not on the ground, they finally touched down almost half way down the runway, full reverse selected, the auto brakes started working.

The Tower Controller

The aircraft almost didn't land; finally it did and started braking. She had observed the same situation before, you think the aircraft will not stop before the end of the runway but it always does. She was very surprised when it almost stopped but then continued slowly off the paved surface and onto the grass area beyond. Perhaps better postpone the trial of my new barbeque sauce she though as she pressed the alarm button.

Case Study Comment 1 by Dragan Milanovski

Could it be complicated to land an aircraft safely?

Well, we all know that although it might be complicated to land an aircraft safely, it is achievable with rare exceptions. This case study describes one of these exceptions, where a landing aircraft failed to stop before reaching the end of the runway.

Dragan Milanovski

is ATC training expert at the EUROCONTROL Institute of Air Navigation Services in Luxembourg.

Most of his operational experience comes from Skopje ACC where he worked for a number of years on different operational posts.

Now, his day-to-day work involves ATC training design as well as Initial Training delivery for Maastricht UAC.

The D-Line crew was returning to Angel's Town, which was a familiar place to them, on a lovely summer evening where the weather seemed to be perfect for barbecuing. It all started when the captain accepted the first officer's suggestion to ask for straight-in approach runway 12. If it wasn't for the first officer's idea it would have probably been suggested by the approach controller. Pilots ask for shortcuts / directs / straight-ins on a daily basis. Controllers' standard practice includes offering shortcuts and diversions from standard routes especially when this helps solving conflicts and improves sequencing. Overall, it leads to fuel saving and more efficient utilisation of airspace. I don't think that it was a factor in this case.

One might argue that the approach controller was not busy and was not focused on handling the traffic (lovely colleague with good sense for humour; reading a newspaper when in position; thinking about the conference) and he had too much time to think about the two aircraft he was controlling. If the traffic was busy he might have had to deny the pilot's request for straight-in approach runway 12. Maybe… we will never know.

The captain was aware that the aircraft was a bit high and that he would need to do something about it and so he asked for delaying turn. However, this was not the approach controller's expectation; he was trying to get the D-Line out of the way of another aircraft; so he decided to put on some extra pressure by asking the D-Line captain to keep the speed up. It is important to mention here that the complexity of human relations could also have played a significant role. I am guessing that the captain was probably thinking that the controller had done him a favour by approving the straight-in approach and he needed to keep the speed up in return. He did not know exactly what speed was required to solve the problem nor for how long he needed to maintain it. In these circumstances, the captain will probably "stretch it" to the maximum, hoping not to disappoint the guy who did not think twice before approving his request, when that might not be absolutely necessary, or at least not necessary all the time or at such high speed. Specifying the speed and the limit is usually a better solution. Nevertheless, I think the controller acted according to the standard culture like every other controller on any other day… so far.

Then the vectoring for approach was done under pressure to shorten the D-Line's track distance and the aircraft joined final inside 6 miles from touch down. Although this is not recommended, it is also one of these things that happens almost daily and usually they end safely. The approach controller failed to recognise that there were too many factors working hand-in-hand and maybe vectoring inside 6 miles to intercept the glide path from above was not a good idea on this occasion. Bearing in mind that they never discussed runway excursions at work and that he did not know the magnitude of the problem, this is not a surprise.

In the meantime, the surface wind changed significantly. When the captain was informed about the new wind, he did not react at all; his mind was set and committed on landing the aircraft. The first officer's call that the wind had increased was dismissed relatively easily by the captain who intimidated the first officer (I landed here before you were born). It also looks like the crew was not aware of the recent heavy rain and the fact that the runway was wet and probably contaminated with standing water. Although the tower controller was a bit late with fixing the new met report, the information about the wind change did reach the crew in time. Can we blame "her new barbecue sauce" for keeping her thoughts elsewhere? No, I do not think so. It was business as usual I would say. It is normal to think of other things when you are sitting in a position with low (or no) traffic. Eating her lunch while working, well – I would not do it. I like to enjoy my lunches.

The aircraft touched down almost half way down the runway (beyond the normal touchdown zone) with significant tailwind (excessive ground speed) on a wet runway and probably contaminated with standing water (reduced breaking action). Failing to stop at the end was the likely outcome.

Why? What made the difference this time?

It seems that this is another story where everybody involved was doing what they usually do. There were several major and few minor factors (mentioned above) that were contributing to each other and all were working in the same "direction". There were many chances to alter the outcome of this event by taking a different course of action, but it did not happen. The last and most crucial took place when the captain decided to continue approach after passing 500 feet above ground level with his aircraft still not properly stabilised on approach. He should have decided to go around at that point. The D-Line company will have to do some work on strict enforcement of stabilised approach criteria.

RECOMMENDATION

The ATC establishment in this story needs to increase the awareness of runway excursions, as well as awareness of control actions which can contribute to unstabilised approaches. I recommend a small training package comprising of all the main and contributing factors, with a few case studies that illustrate typical scenarios alongside the associated risk mitigation techniques, to be included in the refresher training for air traffic controllers.

Case Study Comment 2 by Captain Ed Pooley

The outcome here could have been a lot worse, just a little bit faster off the end and a few obstacles and you have a potentially fatal accident…

What can we learn from it? The scenario is not unusual – all the actors are doing what they normally do with a universally relaxed approach on a day when all the equipment is working normally and the weather is nothing special. The controllers are reading the paper or letting their minds wander a little and the flight crew talking 'intently' about one of the two favourite routine concerns of all flight crew – rosters (the other is crew meals!). All the players were in 'underload' – which can be as risky as the more complained-about 'overload' and experience has shown this. It is just these circumstances where complacency easily creeps in and bad habits which normally have no effect, are ready to line up and create a potential accident and then help ensure that it becomes one.

Let's start by commenting on the end-game. The air hostess (with that title, our author is either betraying his years or watching too many old films!) started her arrival PA prematurely, before the aircraft has cleared the landing runway. She switched too early from her primary safety role to her secondary 'customer service' role. Not difficult to do really insofar as the safety role of cabin crew is rarely called for despite often being of crucial importance when it is. We don't know if this arose from a breach of D-Line SOP or whether they had failed to specify or train the right

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He now works as an independent air safety adviser for a range of clients and is currently acting as Validation Manager for SKYbrary.

Case Study Comment 2 (cont'd)

timing of the post-landing change of role emphasis, but either way this needs fixing for the day when the outcome is less benign…

Now to the developing accident scenario. Flight crew these days are pre-programmed to carefully consider opportunities to get to their destinations as quickly as possible while also using the least possible fuel. The days of automatically maintaining maximum speed are gone - fuel use considerations must also be taken into account and there are typically also automatic maximum speeds below FL 100 even before ATC step in with specific speed control. Finally, stabilised approach 'gates' must be passed with recommended and ultimately fixed aircraft state conditions met in order to continue. So the main thing the crews look for is a shortened routing as offered on this occasion by the helpful approach controller – even before the captain had asked for it!

The actual scenario – a judgement call for ATC about whether it would work if the approaching B-Line and D-Line were sufficiently far apart for them to approach and land using opposite directions of the same runway. The decision to go for this option was based upon some unverified assumptions about the groundspeed and tracks of the two aircraft. Having decided that it was unnecessary to place any specific conditions on the D-Line straight in clearance, the Approach Controller then acceded to the request for a track miles increase rather than review the initial straight in clearance. He decided that it would 'probably' not be in conflict with B-Line…

Of course, pilots are often their own worst enemies. By nature and training they are can-do people who sometimes temporarily vacate the middle ground between the extreme version of 'can-do' and the extreme version of 'overcautious'. Like ATC, the captain is determined to keep to the original plan – it would be a shame to add ten minutes to the flight time when it simply wasn't necessary to do so.

Neither ATC nor the captain considered in advance the possibility of wind velocity variations during the approach, given the Cbs in the vicinity and a wind already close to the maximum allowable tailwind limitation. And when the updated wind was passed on, with the aircraft already above the ILS glideslope and the prospect of an EGPWS activation growing, the fact that the tailwind component was now well outside landing limits was either positively ignored or just passively overlooked by both pilots. Finally, the mandatory 500 ft stabilised approach criteria were consciously breached by a captain fully overconfident about his skills without even a comment from the 'monitoring pilot'. Of course, such interventions against the flight deck 'authority gradient' are never easy - but it is every operator's job to make sure that they can, and do, happen whenever the need arises and that critical SOPs, such as stabilised approach gate criteria, are never breached.

RECOMMENDATION

ATC helped set up this accident but, as is usually the case in human factors scenarios, the flight crew caused it. Taken together, the poor decision making and ineffective teamwork on the flight deck and the blatant disregard for stabilised approach criteria are unlikely to be a one-off in D-Line. Either the existing flight operations manager has failed to find ways of keeping themselves informed about what's really happening on the line, or they were aware and tacitly condoned it. Either way, they are clearly past their 'sell by' date and should be replaced by somebody capable of improving the prevailing flight operations culture in D-Line - and who will have a mandate to do this from the D-Line accountable manager.

Case Study Comment 3 by Alexander Krastev

Alexander Krastev

works at EUROCONTROL as an operational safety expert. He has more than 15 years' experience as a licensed TWR/ACC controller and ATM expert. Alexander is the content manager of SKYbrary.

The factor that played a primary role in this RE incident is the decision taken by the APP controller to permit opposite direction approaches...

Although not a standard practice, opposite direction approaches have for years been an operational practice at many airports. Such approaches were not an exception during my TWR controller years. However, the incident statistics at our ATC unit clearly showed that opposite direction approaches led more often to incidents of more severe consequences. The development and implementation of dedicated procedures did not change the level of risk significantly. Opposite direction approaches require very high precision of planning and acting both on the ground (by APP controller) and on board (by pilots). Even a small deviation from the estimates can dramatically complicate the situation. There is very little time to react and quite limited options to resolve the dangerous situation. That is exactly what happened in this story. The APP controller's plan collapsed when the D-line pilot asked permission for a delaying turn.

The flight crew contributed to the primary trigger of this chain of events – the decision for opposite direction approaches - by giving the 'final push' to the APP controller. Despite being aware that the aircraft was "a bit high" for a straight-in-approach to RWY 12 the captain agreed to the FO suggestion. Moreover, one could argue that the APP controller was mislead by the crew because at the time the FO asked the permission, the crew were aware of the need to extend the approach to lose height. Such a hypothesis stands on the fact that the crew asked for the extension immediately after getting the permission for straight in RWY 12.

The next important stage where the sequence of events leading to the incident could have been broken was the decision point for the APP controller whether or not to clear the D-line for a delay turn. Without proper assessment of the situation and the potential consequences, the APP controller issued the clearance. This way the initial plan to use opposite runways for landing in order to provide optimum flight paths to both arriving flights has quickly turned into a fast developing situation beyond the chances for effective control by ATC. Perhaps physiologists and human factors experts could tell us what the chance of recognising a failed plan at an early stage is, but I will not bet my dinner on it.

The snowball effect of the flawed decision should not come as a surprise to any experienced controller or pilot:

- Stress in the cockpit owing to the speed restriction late into the approach and late final joining. These are typical contributors to unstabilised approach.
- Stress in the APP and TWR caused by the unexpected increase in wind speed and the uncertainty about the outcome of this non-routine situation.

The captain's decision to disregard the EGPWS warning and to continue approach despite the aircraft position in relation to the glide path (well above) and the high tail wind component (perhaps exceeding the limits set in the AOM/SOP) made the situation worse and the unwanted outcome almost sure. Instead of going round, he decided to land. The unstabilised approach supplemented by inadequate assessment of the situation and captain's overdone self-confidence led to a long overshoot on landing and eventually runway excursion.

One should not overlook the contributions of the TWR controller and the FO to the incident. The complacency displayed by the TWR controller who put lunch higher than the professional obligations in her priority list (I could hardly believe this can happen in reality) led to late notification of the APP controller and the crew of the increased wind speed. The FO did not question any of the decisions and actions of the pilot-in- command. This could be explained by his failure to follow the SOPs or by organisational factors, such as lack of or inadequate CRM, inadequate SOPs or even an organisational culture which tolerates high risk inducing behaviour.

There were a number of other risk contributing factors that, in my view, did not play a role in this particular event, but are important precursors which should be acted upon by management and staff responsible for safety in an organisation, notably:

- Distraction – displayed by the APP controller who was reading a newspaper at his working position
- Unsafe practices at organisational level – tolerating reading newspapers in ops room and 'single man' operation in the TWR (may be in breach of the operational procedures).

RECOMMENDATION

How could such incidents be prevented from happening? Opposite direction approaches should not be permitted unless the concerned flights are separated by a safe time/distance calculated on the basis of the difference between the estimated times of landing of the concerned flights.

Nearly a Runway Excursion

In keeping with the name of our publication, we have decided in this issue to begin a new column which will draw attention to an accident or incident which has shown, through investigation, that there are lessons to be learned from it. Usually, we will choose a case relate to the theme of the issue.

SKYbrary contains a searchable library of articles on several hundred selected accidents and significant incidents, most of them investigated independently under the procedures called for under ICAO Annex 13. The original investigation report on each selected event may also be found on the SKYbrary bookshelf, either as first published if the primary language used by the investigating agency is English, or in an 'official' English Language translation if not. Here, we will just give a short summary of what occurred and note the main findings. For more detail, you should refer to SKYbrary!

The Place: St Kitts, Eastern Caribbean
The Date: 26 September 2009
The Weather: Good
The Event:

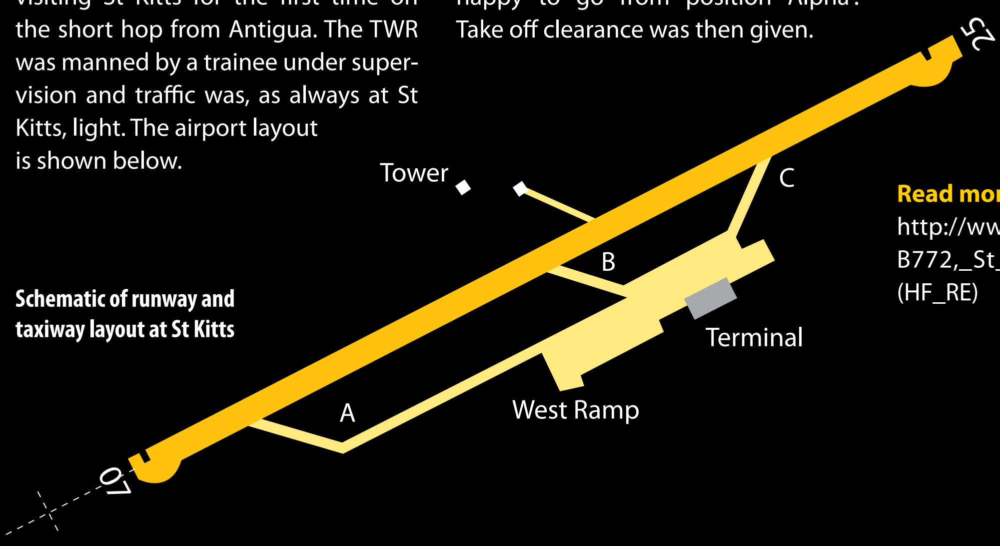
A British Airways Boeing 777-200 operating a daytime passenger flight from St Kitts to Antigua unintentionally began and successfully completed take off from a different intermediate position on the departure runway than the one intended and just succeeded in becoming airborne before the end of the paved surface was reached. Red faces all round, not only for the aircraft crew and ATC, but for the Airport Operator and the local CAA too. At least there was no damage and no injury, just another near miss!

The route was quite new and operated infrequently. Both flight crew were visiting St Kitts for the first time on the short hop from Antigua. The TWR was manned by a trainee under supervision and traffic was, as always at St Kitts, light. The airport layout is shown below.

ATC cleared the aircraft to taxi to intersection 'A' and then to backtrack for a 07 departure. The crew had established that there would be sufficient take off distance from this point without the need to backtrack. Following a departure briefing which had not included the expected or possible taxi routings, the aircraft taxied instead to Intersection 'B'. After a short wait at 'B', ATC were advised that the aircraft was ready for departure and responded with line up and departure clearance. As the aircraft entered the runway and began to turn towards the departure heading rather than backtrack, ATC inquired slightly hesitantly whether a backtrack was required and the response was, "err negative…we are happy to go from position Alpha". Take off clearance was then given.

The captain observed that the runway ahead looked very short and decided that a substantial application of thrust against the brakes prior to brake release would be sensible. Take off commenced and V1 was achieved as the aircraft reached the opposite direction Touch Down Zone markings. Rotation followed and lift off was achieved just before the end of the runway…

The investigation noted that the operator did not authorise Intersection 'B' departures for Boeing 777 takeoffs from Runway 07 at St Kitts and that the aircraft had taken off with an actual take off run of 1220m available, compared to the calculated one from intersection 'A' of 1915 m. It was established that there was no taxiway or holding point signage anywhere at St Kitts.



Schematic of runway and taxiway layout at St Kitts

Read more at:
http://www.skybrary.aero/index.php/B772,_St_Kitts_West_Indies,_2009_(HF_RE)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A slippery business

By Marcus Blomlöf, Supervisor Stockholm Arlanda TWR

It is well known that contamination on the runway may be a contributing factor to a runway excursion. In Sweden, known for warm and dry summers, the contamination mostly consists of snow and ice in the winter...

Stockholm Arlanda airport is situated in the far north of Europe where winters are crisp and cold. The airport normally has winter conditions at least 4 months a year. Snow clearing and de-icing procedures on runways and aircraft becomes a routine business - with some 2 metres of snow falling last season this is understandable. With the standard two runways open, the airport can still continue to function even during prolonged snowfall. How is this done? How do we maintain good braking actions? How do we prevent runway excursions?

The big difference in weather conditions during the year makes ATC work highly diverse, especially for the tower controllers. Mixing a group of large sweepers and aircraft makes an interesting challenge. During a standard winter day, the supervisor in the tower works very close with the person from the airport in charge for the airside snow clearing. This is vital to ensure the best appreciation of the runway status and assessment of breaking conditions and contamination.

The airport supervisor for the snow clearing is responsible for the condition of the runways, taxiways and aprons. He or she decides what to do, when to spread de-icing fluid, etc. The standard way to remove the snow is to use a group of sweepers for a circuit around the airport including two of the runways and associated taxiways. A typical circuit for the sweeper group at Arlanda takes 48 min. After 48 min, if it is still snowing, they start it all over again. Timing is everything; the sweeper group has to be ready to start clearing the runway when the final arrival touches down. No lingering allowed on the runway, the next arriving aircraft are exactly 12 min away.

To clear runway 01L/19R (3301m) with a group of 8-10 sweepers takes 10 min. Following the sweepers are 2 friction testers (Two SAAB 9-5, same as Chicago O'Hare) which measure the breaking action. It takes an additional 2 minutes to measure, calculate and publish the friction values, including the contamination.

This value is then given to the aircraft using the now snow-free runway. The breaking action value is accurate at the time of the measurement. No estimate of the future value is given, only the value and the time of the measurement. In heavy snow this means that the values may be worse than the latest published figures. However, pilot reports are also taken into consideration. After all, Scandinavian pilots are used to winter conditions. However, if you are the last aircraft using a runway before the sweepers starts clearing, the values that ATC gives you may be relatively old…

Of course, to measure the friction the two vehicles have to be on the runway. If you want to measure the number of landings more often, departures will consequently be reduced which may create delays. It's a thin line between keeping an adequate and up to date friction value, while trying to use the runway to accommodate as many air-

The drivers of the trucks, ploughs, blow sweep-ers, snow blowers etc. are typically seasonal employees, making an extensive training program before each winter season necessary.

craft as possible. Again, here is when the professionalism and experience of the supervisor for snow clearing is of highest importance and value. With their deep knowledge and experience, their judgment is one of the most important tool for keeping the runways and taxiways in a good condition; if needed they make the decision if and when to spread de-icing fluids on the runway. For this, a modern type of (environmentally friendly) fluid is used, which has the ability to reduce the freezing point. The Aviform product that is used at Arlanda can be spread down to -50C, it is mixed with water (!) to make it as efficient as possible. However, spreading de-icing fluids on the runways is no miracle cure against runway excursions; it has to be carefully evaluated. The fluid is always efficient but needs to be carefully monitored, e.g. followed by sweeping within a certain time period to avoid freezing.

The condition of the runways and taxiways is always the top priority. This may, as a spin-off effect, have an impact on the apron conditions. Sometimes, pushback trucks are unable to get a grip on the icy surface. The solution to this is to spread warm sand in front of the truck, an efficient but very time consuming way of dealing with poor friction! The breaking value on the apron can stay poor during extensive periods during the winter, but the snow is always removed (sooner or later!) allowing the aircraft to enter and exit the gates.

SOME FACTS

Surface Liquid de-icing	684.842 Litres
Sand	2.850.000 kg
Aircraft de-iced	9468
Number of days with snow clearing	110
Snow 2009/2010	190 cm
Largest amount of snow during one day	23 cm
Total area to clear of snow	2.946.043 m^2

The system using 2 runways even during a longer snowfall has proved very effective. Delays are kept to a minimum while being able to land and depart regularly and independently of each other. A few days each year however, the weather conditions become extremely severe, making it impossible to operate two runways. Typically this is often the case when snowfall is combined with strong winds that polish the surface of the runway. The polished surface has to be ground down using blow sweepers and this requires the sweepers to enter the runway more often. The circuit takes around 30 min; it may reduce the operational available runway time to 36 min per hour. This will normally build up delays but luckily this situation is rare, normally a light to moderate snowfall have a surprisingly low impact on the throughput.

The drivers of the trucks, ploughs, blow sweepers, snow blowers etc. are typically seasonal employees, making an extensive training program before each winter season necessary. It is important to ensure not only how to handle the vehicles, but also how to use the radio and how to navigate the airport including where clearance is needed and where it is not.

One challenge for the tower controllers during snowfall is to keep track of all the vehicles that are busy with the snow removal. Starting from the winter season 2010/2011 all vehicles will be equipped with a transponder making them securely identified via the multilateration system. To further ensure the integrity of the runway, the use of stop bars is mandatory.

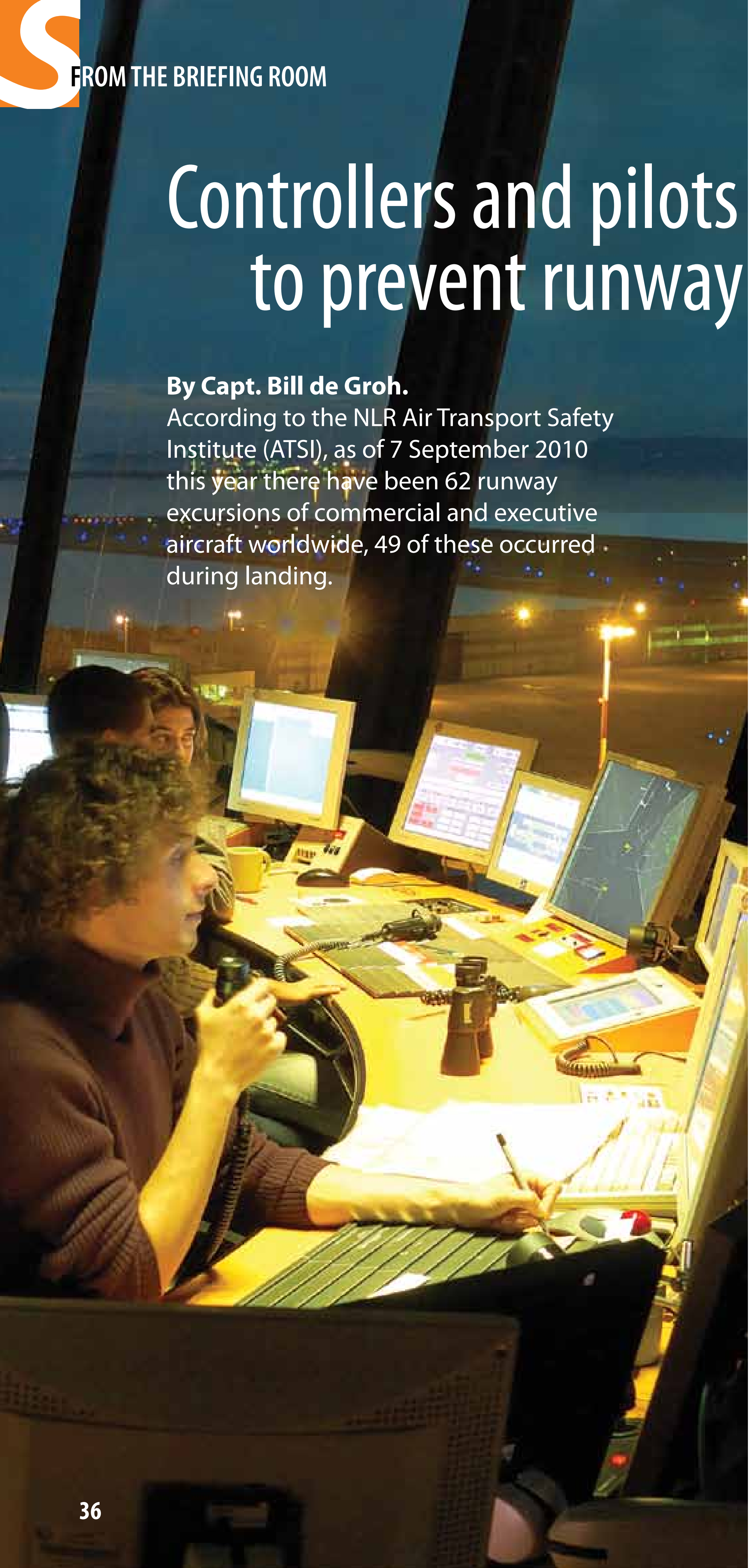
To maintain high safety and throughput, the airport and ATC have developed good coordination procedures and also invested in training and equipment. The cost of keeping 12 sweepers, support vehicles and drivers available 24/7 is not to be underestimated. However, this investment is essential, as we often have winter in Sweden. Even with careful preparation and long experience, each winter season is a new challenge, snow has a strange habit of falling when it is least expected….

And we do not like runway excursions! S

Marcus Blomlöf

is a Swedish ATCO and has been a (the) Supervisor at Stockholm Arlanda Tower since 2008.

Controllers and pilots teaming up to prevent runway excursions



By Capt. Bill de Groh.

According to the NLR Air Transport Safety Institute (ATSI), as of 7 September 2010 this year there have been 62 runway excursions of commercial and executive aircraft worldwide, 49 of these occurred during landing.

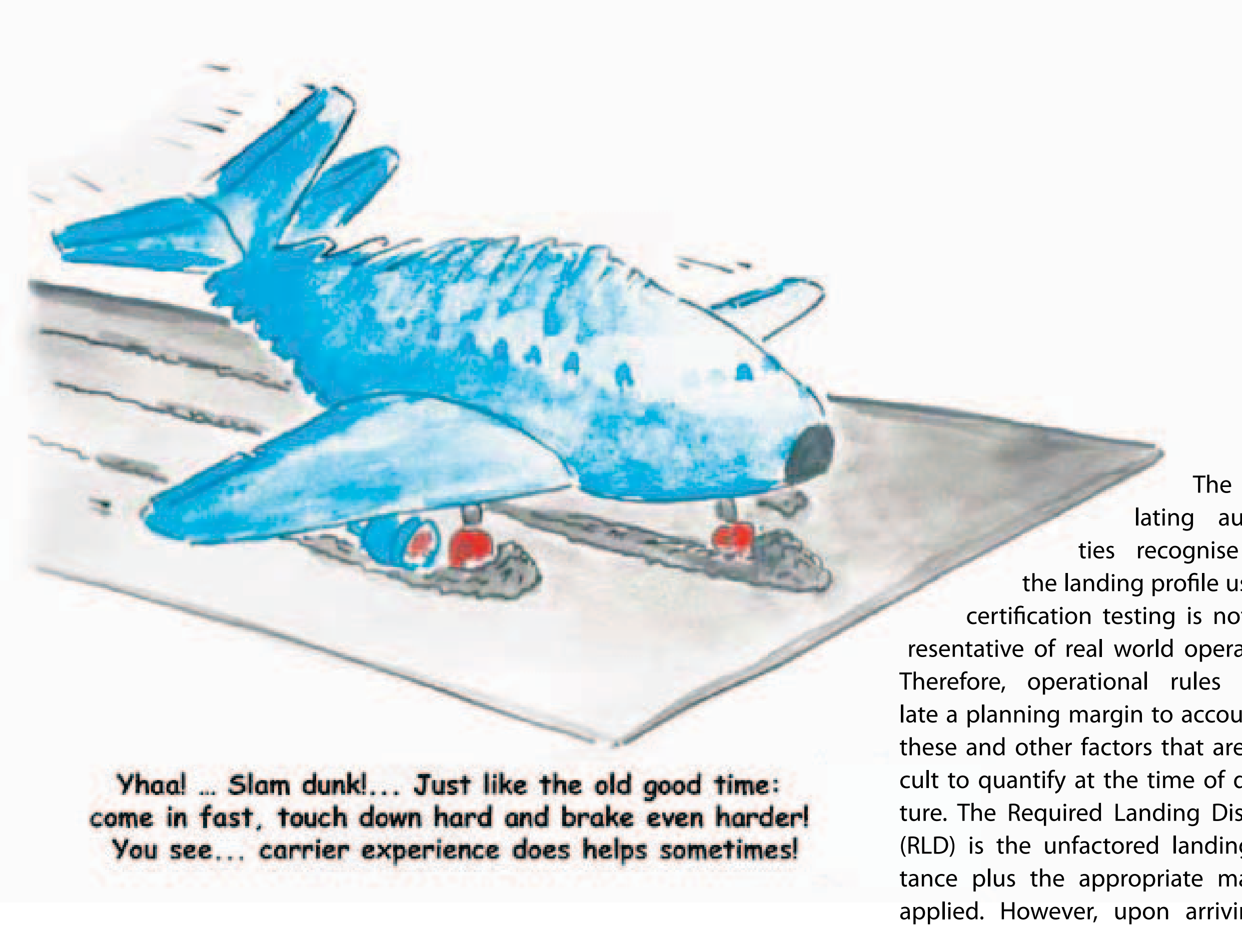
These 49 landing events were almost evenly divided between veer offs and overruns. Obviously, when an aircraft leaves the prepared surface on landing, the potential for injury and death exists.

As a current air line pilot and former aerospace engineer, a discussion of landing performance among pilots comes naturally. Although the aircraft commander is ultimately responsible for ensuring a safe landing, commercial air transport is a team effort, so can air traffic controllers assist the aircraft commander in this task? I believe the answer is yes.

First, it will be necessary to understand how the Airplane Flight Manual (AFM) landing performance information is determined by the aircraft manufacturer. That background will highlight the factors that affect landing distance which will then point to areas where controllers can assist the pilot.

Certified Versus Operational Landing Performance

The actual landing distance determined during certification testing is defined as the horizontal distance necessary to land and come to a complete stop from a point 15 m (50 ft) above the landing surface, assuming a level, smooth, dry, hard-surfaced runway. The distances determined are based on standard temperature, accounting for aircraft weight, wind, and altitude. The aircraft must be in the landing configuration using a stabilised approach, crossing the 15 m height at a specified speed. No credit for thrust reverse[1] is allowed and maximum manual wheel braking is used. The



distances thus obtained represent the maximum capability of the aircraft, sometimes referred to as the certified or unfactored, landing distance. Let's see how these requirements relate to real-world landings.

Notice there is no correction for non-standard temperatures. Temperature and pressure conspire to increase true airspeed for a given altitude, resulting in a longer landing distance. Many airports have sloping runways and landing down slope, of course, increases landing distance. The data determined is only for dry runways. A wet, smooth surfaced runway definitely will not behave as well as a wet, grooved runway. Neither runway is dry but a grooved runway provides better drainage and improved braking effectiveness when wet. The unfactored landing distance does not account for contaminated runways. This information can be found in "advisory data" which is generated by conservative calculation, not through certification testing. Not all authorities require their operators to use this advisory data.

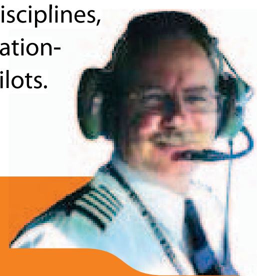
1- This includes use of reverse pitch in turboprop aircraft.

The unfactored landing distance comprises two segments; an air distance and a stopping distance. The air distance begins at 15 m over the landing surface and ends at touchdown. Aircraft certification authorities have accepted an air distance fixed at 305 m or a speed dependent value on average of 460 m. For available landing distances more than 2 400 m, the touchdown zone markings extend a minimum of 900 m. This means landing at the far end of the touchdown zone increases actual landing distance 440 to 595 m. This can happen if the aircraft has excessive height over the threshold and/or the pilot extends the flare to achieve a soft touchdown.

The second segment of the landing is the stopping distance which, of course, begins at touchdown. Not including a thrust reverse credit in the unfactored data is conservative, as long as the aircraft is equipped with an operative reverse thrust system. Remember the unfactored data uses maximum manual wheel braking, which is something few pilots do in normal operations; on a dry runway the deceleration rate is, indeed, alarming to pilots and passengers alike.

The regulating authorities recognise that the landing profile used in certification testing is not representative of real world operations. Therefore, operational rules stipulate a planning margin to account for these and other factors that are difficult to quantify at the time of departure. The Required Landing Distance (RLD) is the unfactored landing distance plus the appropriate margins applied. However, upon arriving at the destination, the actual conditions under which this planning was done, may have changed. Some operators provide operational landing distance information via ACARS, an onboard performance computer, or even paper tables. This information may be based on the same assumptions used in the certification data but including adjustments for pilot braking action and use of thrust reverse, with a minimum total margin of 15%. As you can see, landing distances are not as straight forward as they may seem.

Safe commercial air transport is a team effort involving many disciplines, not least of which is the relationship between ATM and pilots.



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Controllers and pilots teaming up to prevent runway excursions (cont'd)

So, what can ATM personnel do to help ensure a runway excursion does not happen at their airport?

Threat Management

Two air traffic techniques immediately come to mind that can have an adverse effect on landing distance; high-speed approaches and the "slam dunk"[2]. One of the elements upon which landing distance is based is a stabilised approach. When speed assignments to the marker are issued to expedite traffic flow, then the threat of not achieving a stabilised approach is increased. There is one State's ATM organisation for which it is not uncommon for a pilot to receive a speed assignment of 180 knots, or I've even heard of 200 knots, to the marker. By accepting the high-speed approach, a pilot may be working against the edges of safety to get the aircraft configured, on path, and on speed by the threshold. Similarly, keeping the aircraft high and close-in to the airport for noise abatement, or for moving traffic below, can make achieving a stabilised approach a challenge. It can be difficult to go down and slow down, possibly resulting in excess height and/or speed over the threshold.

As far as approach speed assignments are concerned, there are times when spacing becomes tight between an aircraft that has just landed and the next on short final. The landing pilot may, but generally should not, receive instructions while rolling out to expedite exiting the runway. Given that instruction and knowledge of the

2- The "slam-dunk" is a type of basketball shot in which the player jumps up near the basket and powers the ball manually through the basket with one or both hands over the rim. In aviation a "slam-dunk" occurs when an aircraft is held high close-in to the airport by ATC and then cleared for a visual approach.

There is one State's ATM organisation for which it is not uncommon for a pilot to receive a speed assignment of 180 knots, or I've even heard of 200 knots, to the marker

proximity of the approaching aircraft may lead a crew to cut the corner of a taxiway resulting in a veer off, or take an exit that is closed due to construction. Don't be surprised when a flight crew declines such suggestions, as they may do for safety.

Maintaining use of a runway with a tailwind component for noise abatement or simply to avoid traffic issues with nearby airports, especially if the runway is other than dry, is definitely a risk factor. This technique played a role in the Southwest Airlines accident at Chicago's Midway airport.

Accurate runway surface condition reports greatly assist the pilot in determining whether to attempt the landing. When the runway is contaminated, it is also helpful to know where the preceding aircraft exited the runway. This information is useful when considering a runway exit plan, since unused portions of a contaminated runway are often much more slippery than the commonly used areas.

A delay in deployment of thrust reverse, spoilers and/or brakes obviously has an effect on the landing distance. These delays can happen due to distractions that occur when ATM issues initial taxi instructions even before the aircraft's nose wheel has touched down. We all understand the pressures placed on us with the increased tempo of operations, but all of us, pilots and controllers alike, must step back and not let those pressures cause us to rush.

At the end of the day, pilots and controllers are part of a vast team that works very hard to make commercial flight operations safe and efficient. Although pilots may decline a request for a high-speed approach or a tailwind landing, please understand that this is not intended to cause ATM difficulties but a consideration of all the elements discussed above. Controllers can do their part to reduce the risks of runway excursions by considering the effects of high-speed approach clearances, the "slam-dunk", preferential runways, and issuing taxi instruction on the rollout. As teammates, let's help each other out.

Runway friction characteristics measurement and aircraft braking

by Werner Kleine-Beek, Research Project Manager, European Aviation Safety Agency. In April 2008, aeroplane operational issues fell under the European Aviation Safety Agency scope. At that time, the European Commission had clearly indicated that in the future, aerodrome operations will also be under the responsibility of EASA. This extension of the Agency's responsibilities was adopted on 7 September 2009.

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Instances of runway overruns and veer-offs, where ice, snow, slush or standing water patches are contributing factors, have been a constant issue for aviation. As part of the process of defining runway surface conditions, friction measurements are commonly made at present using various ground friction-measuring devices. These devices differ substantially among each other with the result that different readings are obtained from them on the same surface. This lack of harmonisation poses a potential safety hazard.

The issue of runway friction characteristics measurement is a multidisciplinary one, mainly between operations and aerodromes, but also with regard to aircraft certification. There was little doubt that the safety of aircraft operations could be enhanced if reliable, accurate and consistent methods of both assessing the braking action available on a contaminated runway and applying this assessment to aircraft performance could be devised.

Werner Kleine-Beek

joined EASA 2007 as Research Project Manager, being responsible for management of the Agency's research projects as well as coordination and interfacing with other research programmes. He started his carrier as research engineer for train traffic control systems, worked after as avionics systems certification engineer and in Aviation and Space Department of the German Federal Ministry of Transport responsible for technical issues in aviation administration, space activities, and the Ministry's research programme & research coordination.

Runway friction characteristics measurement and aircraft braking (cont'd)

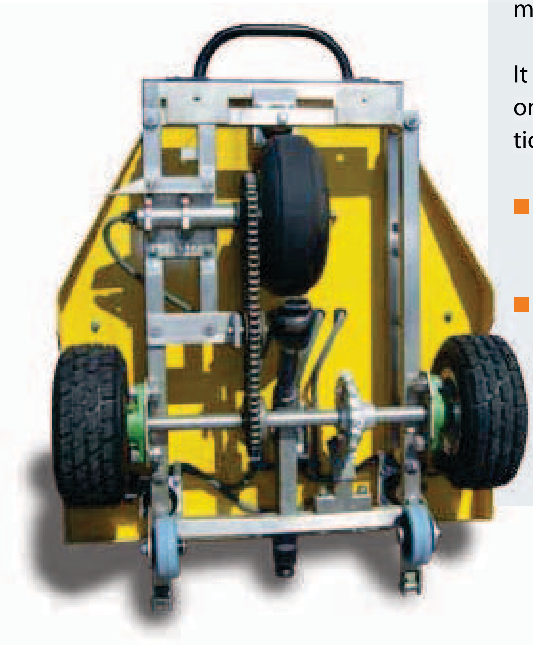
However, the magnitude and possible regulatory complexity of the task should not be underestimated.

The "RuFAB" project

In 2008 the Agency launched the research project "RuFAB – Runway Friction Characteristics Measurement and Aircraft Braking". Its aim was to help identify possibilities of harmonising runway friction characteristic measurement technologies and provide a basis for improving and harmonising the implementation of current ICAO Standards and Recommended Practices (SARPS) within the EASA Member States. This could provide the opportunity for a global standardised application, and contribute to the progress of the ICAO action plan. Finally, it would prepare prerequisites to the future EASA rules for aerodrome safety.

The recommendation from the report and an EASA workshop with the relevant stakeholders consists of two types of recommendations:

- Recommendations that EASA should consider enacting, and
- Recommendations of a more general nature that would require other groups (than EASA) to action, or that would require a collaborative effort.



Examples of Recommendations that EASA should consider enacting

[1] General issues, such as taxonomies and definitions

- **The runway state** – the aviation community is trending towards a three-level definition in that a runway is either: (i) dry; (ii) wet; or (iii) contaminated. The current EASA definitions (in CS-25) employ a three-level definition, and it is recommended that EASA maintain this.

- **The definition of contaminants** – EASA CS-25 - provides a list for the purposes of aircraft certification. This list is incomplete as other contaminants also occur. It is recommended that EASA expand the list in CS-25 as appropriate.

- **Runway coverage producing contaminated conditions** – EASA CS-25 defines the criterion as being 25% coverage of the reported runway length and width. ICAO Annex 15 is one exception, and it is recommended that EASA review this variation.

- **Damp** – it is recommended that a definition for damp be retained.

- It was recognised that there should be harmonisation between the definitions used for defining aircraft performance and those used for describing the runway surface condition. A table of recommendations was produced.

- The most serious gaps in the present set of definitions are considered to be:
  Layered contaminants – a multitude of cases are possible.
  Frost – suitable definitions are generally not available.

- **Training programs for:**
  Pilots – a training program should be developed and implemented for pilots regarding how to use the information provided from runway condition reporting.

  Runway inspectors (RIs) – Certification requirements are required for runway inspectors (RIs), and for staff issuing RCRs and/or NOTAMS directly affecting aircraft operations.

[2] Functional friction assessments

There is a fundamental variation between the objectives for functional and operational friction measurements. Correlation to aircraft performance is of much more concern for operational friction measurements.

It is recommended that work related to functional friction measurements focus on developing standardised procedures, including calibration and harmonisation, for the devices, with desired correlation to aircraft as a secondary goal.

- A comprehensive set of technical specification should be developed and incorporated into civil aviation regulatory standards.

- Every friction measuring device should be tested to ensure compliance with repeatability and reproducibility requirements.

  - The use of the European Friction Index (EFI) or the equivalent IFI harmonisation model is recommended.

[3] Operational friction assessments

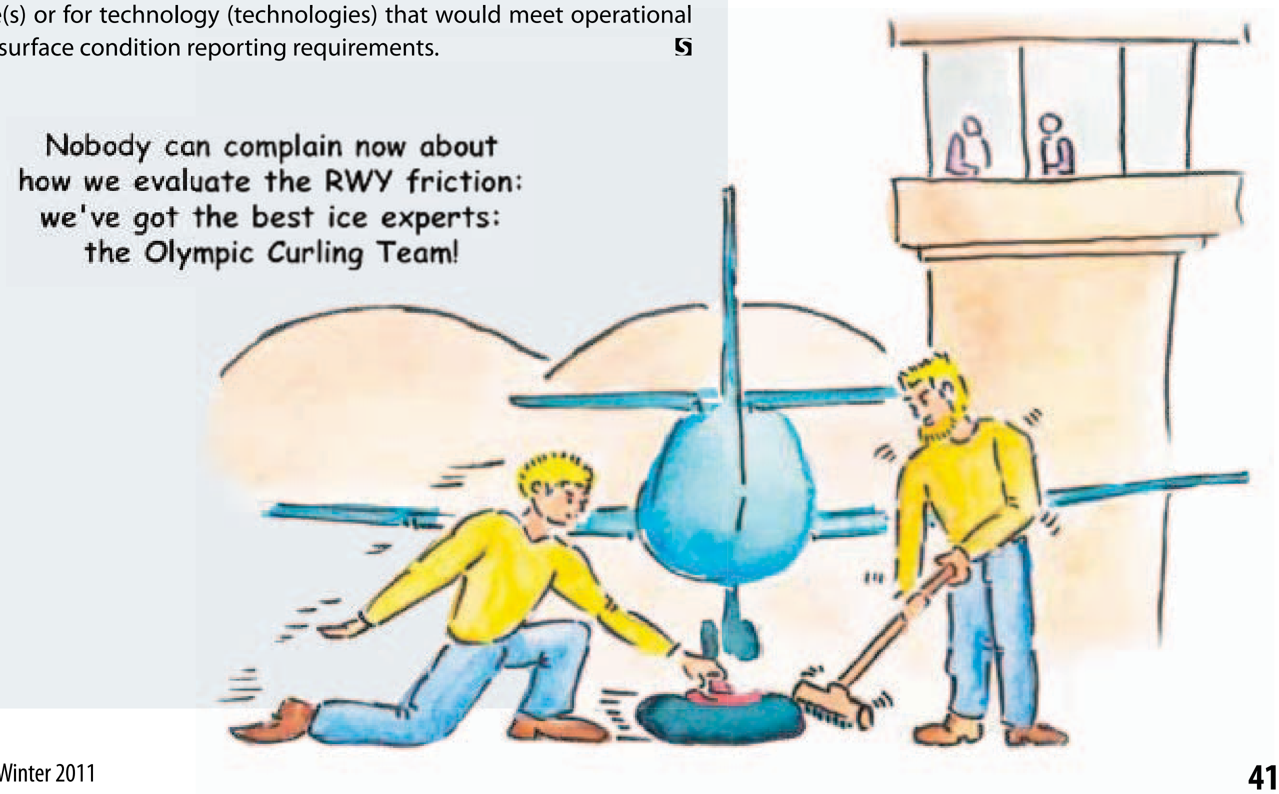
There is a divergence of views within the general aviation community regarding the emphasis that should be placed on observations of the runway surface condition versus ground friction measurements.

It is recommended that fundamental decisions be made by EASA regarding:

- Whether to parallel the trend (being exhibited by a large part of the aviation community) towards de-emphasising friction measurements for operational purposes.
- Updating the current runway surface condition assessment.
- A policy decision to be made by EASA to either regulate the closing of runways for maintenance when predetermined contaminant thresholds are reached, or to recognise that airports' responsibilities are limited to accurately reporting conditions with which carriers and pilots will make aircraft movement decisions.

Recommendations of a more general nature

- EASA should recommend to ICAO that the SNOWTAM form be updated. This recommendation has already been adopted by ICAO.
- Functional Friction Harmonization Trials and Development of Consistent Standards – A stepwise method for conducting a calibration and harmonisation trial has been developed. A pilot study should be done to evaluate the proposed approach.
- There is a need for high-level criteria for a friction-measuring device that is intended for use in operational correlation with aircraft performance.
- A committee should be formed to develop a performance specification for a device(s) or for technology (technologies) that would meet operational runway surface condition reporting requirements.



Runway excursions: cleared to land ...ready or not!

By Graham Wadeson and Anne Isaac, External Safety Team, NATS[1]

Historically there are 30 runway excursion accidents per year, which cost the industry approximately $ 1 billion.

The reasons aircraft end up in unplanned areas at airports are many and various. When a thoroughly robust investigation of events at airports is undertaken, it becomes clear that all the humans present in the aviation infrastructure can contribute to events from small mishaps to catastrophic loss of life 'accidents'.

Data from a EUROCONTROL publication[2] in 2003 reported that runway incursions and excursions are reported in terms of:

- ATC operational errors or deviations,
- Pilot deviations,
- Vehicle/ pedestrian deviations.

In some countries, notably Australia, they also include animal involvement in runway safety events.

The study also made the claim that, unlike many models of attribution (one party being at fault), runway incursion events were a result of multiple involvements and the statistics indicated that of the overall attributable deviations:

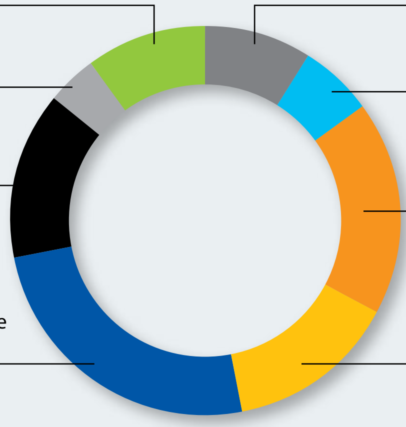
56% were due to pilot deviation,
23% were attributable to the ATM system,
21% were owing to vehicles, animals or pedestrians

However, when you start to analyse runway safety events in a holistic way, it is often difficult to identify where one professional group does not influence all the others; they represent a complex and highly coupled safety system.

As shown below, in the 11 years from 1996 to 2007, the world-wide aviation statistics[3] indicate that there were 7 Runway Incursion accidents with a loss of 282 lives and 220 Runway Excursion accidents with a loss of 458 lives.

Runway excursions can result from either take off or landing scenarios with the aircraft leaving the runway at the side or overrunning the end.

1- Thanks also to Andrew McCarney, Controller, Southampton Airport and Barney Wainwright, Captain, Flybe, for their contribution.
2- Aerodrome Resource Management: Report on Runway Incursions. Internal Report Eurocontrol, 2003
3- Worldwide Statistics on Runway Incursions and Excursions, IATA, 2009



Recent data from Honeywell indicates the following common Runway Incursion and Excursion events

A leading contributor to overruns is an inappropriate aircraft energy state on approach caused or contributed by:

- ATC errors
- poor planning and late 'let-down' by pilots
- poor pilot technique
- landing long
- floating on landing flare
- tailwind
- 'saving fuel' policies

Since it is a collective responsibility to cause or aggravate an adverse safety event, it should also be a collective responsibility to mitigate and manage the consequences of these events.

Although these single issues/errors are clearly interesting (but not surprising), they only give an idea of 'what' happened, but are not informative with regard to 'why' these events occurred. "ATC errors" is hardly a useful category in the aftermath of a serious runway incursion or excursion. It also leaves the investigation of the chronology, with regard to 'who' and 'when' things happened, open to interpretation.

Knowledge with regard to the context which surrounds both incursion and excursion events is vital if we want to improve mitigations for pilots, controllers and vehicles/persons.

As documented by many sources, one of the main causal factors associated with runway excursions are unstable approaches. But if we're honest, from ATC, we know unstable approaches are an issue but we don't really know how big an issue they actually are, at any specific location.

For ATC, the only real indicator as to the scale of the issue is provided by the recorded number of missed approaches, for which the pilot indicated that it was due to being unstable. In these occurrences, the pilots have correctly resolved the situation by recognising and acknowledging the unstable situation and mitigating it by carrying out the missed approach. Pilots can be under considerable pressure these days from various sources to continue approaches, such as economic, legal and commercial, so the fact that the decision was made to break off the approach indicates that a good safety culture/CRM exists and the pilots felt under no pressure to continue.

But even the record of missed approaches doesn't tell the whole story as unstable approaches is a big bucket of reasons into which many causal factors can be placed; ranging from ATC, pilot, procedural, airspace design, weather, other aircraft, workload (cockpit or RT loading resulting in late instruction), aircraft cabin issues ….

The risks associated with a runway excursion and the potential consequences are well documented, but the difficulty in determining the scale of the issue associated with unstable approaches, is in gaining the evidence.

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works for NATS's as an External Safety Specialist, within the Division of Safety, liaising and working closely with airlines and other ANSP's. A controller by background, initially within the military and then area control, Graham moved into airspace design and centre operations which lead to a position as Manager Ops and Training at an airfield, before moving on two years ago to his present role.

Anne Isaac
leads the Human Performance development work in the pilot/controller interface in NATS, UK. She gained her PhD in Cognitive Neuropsychology at Otago University in New Zealand. Her previous work has been in the development of incident investigation tools and techniques in European ATM, the introduction of TRM into the ATC environment and the introduction of Day to Day Safety Surveys techniques into NATS. She has written several book chapters, academic papers and the book Air Traffic Control: the human performance factors.

Example

Most, if not all airline SOP's, will determine a gate height (predominantly 1000' which equates to just more than 3 miles from touchdown) at which point, an aircraft is to be in a "stabilised configuration" (this configuration criteria is laid down within the airline's SOP's)

If an a/c is not in this stabilised configuration on reaching the gate, then the airlines SOPs will dictate that the flight crew should break off the approach and execute a missed approach. If not, then the information is automatically logged by the on-

Runway excursions: cleared to land ...ready or not! (cont'd)

board FDM system and the airline operator will have the chance to be aware of it. The pilot can of course elect at any point of the approach to discontinue the approach, but it is at the gate, that the decision to continue must ultimately be made.

So if an a/c reaches 1000' (the gate) and the criteria have been met, the aircraft can (at the discretion of the captain) continue to make an approach to land. According to the statistics, there has been no problem. Correct?

Maybe, maybe not!

Although the stability of the approach is only officially "measured" (against the criteria) when the aircraft passes through the gate, an unstable approach is usually the result of a series of events involving various causal factors (weather, tailwind, fatigue, pressure, workload, poor planning, pilot error, ATC interaction, procedures etc.), which can occur at any stage of the approach, even as far back as the cruise phase. From the ground, we are never aware of the instances where the pilot has fought throughout the approach against these factors to finally become stable at 1100', meeting the "gate" criteria and continuing to land uneventfully!

Indeed, it is very difficult from the ground to be aware of whether an aircraft has proceeded in an unstable state beyond the gate, going on to land. Only the airlines with their FDM information will have sometimes a better view of the picture.

The only true way of affecting the rate of occurrence and therefore reducing the risk, is to work with all the parties concerned.

These avenues of work can be roughly broken down into two main areas:

- **Procedural** – looking at procedures/airspace designs which may contribute to unstable approaches
- **Educational** – increased understanding and awareness about the subject from both the ATC and airlines sides, so that each understand what, how and why things are done and the implications for the other side.

Like most things in ATM, nothing happens in isolation and as already mentioned, these events involve people from all sides; ATC, airlines and pilots. Much good work has already been produced and more is being undertaken by the likes of FSF, CANSO, DGAC and IATA. Not all the causal factors involved are efficiently addressable, but for those that are, if the chain of events can be broken at any point, a runway excursion may be prevented. The information is out there and it is perhaps a case of changing attitudes and culture that will finally make a difference.

To some degree it is a leap of faith as historically we use event occurrences to measure the frequency. As far as runway excursions are concerned, even without more information, it must be better for all concerned to believe that things can be changed now and not to wait for more occurrences.

Editorial note

Some operators do indeed use 1000 ft as a gate or check height to determine if a go around must be flown when an approach is not stabilised, but others use either 1500ft or 500ft and some set a different height depending on whether the approach is being made in VMC or IMC. Unfortunately, there are still some airlines that have not yet got any rules of this sort.

Some top tips for controllers to help minimise unstable approaches

Controllers

- Brief before a shift with regard to weather, especially unpredictable winds and serviceability of equipment (ILS)
- If you do not have precise weather radar to refer to, inform the pilots
- Be aware of the different and most frequent aircraft types and their performance characteristics, particularly with regard to phase of flight
- Always be aware that despite a good knowledge of aircraft performance, pilots will and do fly slightly differently
- All airline companies have rules regarding final decision heights – most will insist on 1000feet, but advising them of an inappropriate track or height if they appear to be displaced from final approach. If a pilot still confirms established and remains displaced, break off, establish if they are visual, or send the aircraft around
- Provide aircraft with at least two track distance updates from touchdown (downwind and base-leg)-changes in track distances cause the most problems to pilots planning approaches
- Try to maintain a standard 'square' vectoring circuit pattern-if you keep it standard, pilots are able to plan their descents.

Understanding cockpit factors

By Captain Rob van Eekeren

Despite statistics, pilots tend to think that a runway excursion will never happen to them. In many cases, they are correct. However, some will face an uncontrollable aircraft leading to a runway excursion; a horrifying experience.

Research shows that many reasons and factors could lead to a runway excursion. Basically there are two scenarios: an aircraft can either overrun at the end or veer-off at the side of a runway. Overruns often occur after a high energy aborted take-off or landing. Although pilots are trained to abort a take-off before V1, take-off overruns do occur. After landing, pilots may find having reduced braking capability, resulting in less remaining landing distance than expected.

The industry wants high performance at reduced costs; current calculation technology is accurate but only as good as the quality of the input variables. This quality is lacking, thus leading to a false sense of safety. At the same time, efforts are being made towards optimisation of performance, environmental restrictions, payload, fuel, maintenance and operational factors. Without adequate margins to cover for real world system imperfections, safety would be directly negatively affected.

Performance input variables

Let's first focus on the quality of the parameters needed for runway landing distance and take off distance calculation. Runway length, slope, QNH, weight of the aircraft, fuel load and technical status are in general precise. Contrary to these though are; wind, the factual runway friction, and consequent braking efficiency, which are often unreliable. Wind varies stochastically, while runway friction measurements are not always related to the behaviour of the specific aircraft type. A couple of knots more headwind instead of a tailwind could make a difference of up to 5000kg in payload which could lead to an overweight aircraft for the actual conditions. Are such variations in input variables possible and

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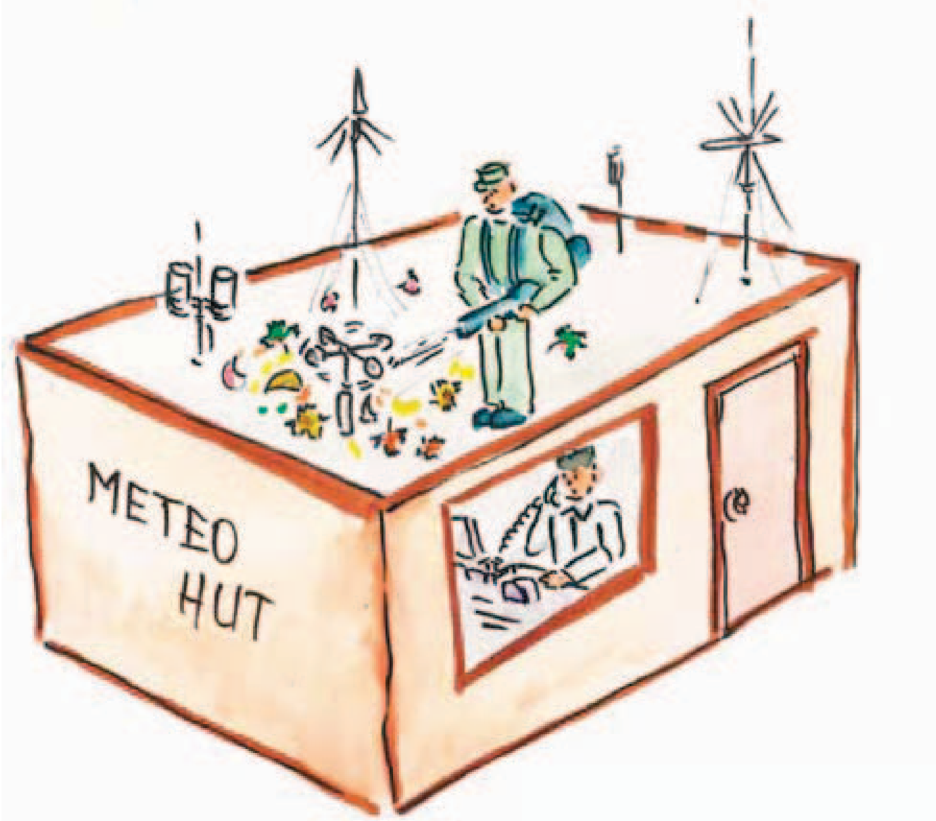
Understanding cockpit factors (cont'd)



My readings show strong wind gusts with rapid direction changes...

realistic? Yes. ICAO Annex 3 allows even for a wind margin of 60 degrees and 9 knots (reporting threshold gusts). The actual runway condition state poses an even greater threat with a possible fault margin of over 100%. Current runway contamination measurement methods give an output that is varied along a runway and not calibrated to relate to aircraft performance parameters often derived by aircraft computers which require and use inputs to the millimetre of accuracy. Due to the lack of correlation between the runway measurement output and the aircraft performance, computation pilots can face an unbalanced take-off without being aware of it. If then faced with an engine failure, an overrun would occur.

Why does this not occur frequently? Probably because the chance of an engine failure at the most critical moment (V1) is very low and landings on critical-length runways in critical conditions are rare. The industry therefore compensates the flaws in the system by luck, if not there, a runway excursion is unavoidable.

Rubber deposits

Another issue is rubber deposits on the runway. After landing, the main braking forces are reverse thrust and aerodynamic drag during the initial high speed portion (> 60 knots), and then the brakes are the main retarding force. When the runway is covered with rubber deposits and when the runway is moist or even wet, there would be virtually no friction left, resulting inevitably in a low speed overrun The same logic applies to contaminated or slippery runways. Rubber deposits are frequently found at the touchdown point, which could be the end of the (opposite) runway in use. That is precisely the low speed area after landing or an RTO and thus likely to result in a slow speed overrun.

Reverse thrust

Another worrying development is the restrictions on the use of reverse thrust for environmental reasons. It does not only take away the most effective braking system during the initial part of the landing, but it also has a huge effect on the brake temperatures. Generally hot brakes do not have the same braking performance or could be the source of a wheel well fire. Performance calculations are not based on hot brakes. Hot brakes caused by a lack of reverse thrust will not only affect the current flight, but also the next flight since dense operations require a quick turnaround. Thus a take-off with possible hot brakes as a result of the previous landing is likely to occur. Hence why a high speed aborted take-off could very well result in an excursion.

Soft landing

Let's get back to the landing. A good landing will help a good run on the runway surface and thus prevent an excursion. However, long landings increase the chance of an overrun. Passengers like a soft landing, but this increases the chances of an incorrect flare followed by floating. But

Rule makers will have to accept that adequate margins are essential to cover for imperfections of the theoretical system.

a too hard landing increases the risk of bouncing and structural failures. Although a firm and correct touchdown, especially in wet conditions, reduces the chance of a long landing, passenger comfort is in normal operations found to be very important. So, when pilots are in the normal habit of making soft landings, it is unlikely that these habits are changed under difficult or stressful circumstances like adverse weather.

A good landing is made possible by a good flare. A good flare is an art, especially in gusty conditions. This requires excellent and regular training or exposure. For pilots based in windy airports, the gust exposure can be up to 50%. But pilots flying occasionally into these airports could face their first windy, gusty landing for years. Autopilot limitations preclude autolands in these conditions. Moreover, the different manufacturers have produced aircraft with different flying and especially flaring characteristics. This, in combination with a lack of exposure and/or training could lead to phenomena known in the literature as, 'pilot induced oscillations', which result in a poor flare and an uncontrolled, hard or long landing.

Stable approach

A stable approach helps perform a good flare. Being at the correct airspeed on the correct glidepath at the extended centreline, with wings level in the correct angle of attack at the right moment describes the best essence of a stable approach. Since flight operations are in a dynamic environment, this ideal situation is virtually impossible to achieve. Thus certain variables have to be within certain limits. The aerodynamics of modern aircraft, being vectored with high or relatively high airspeed, pose a real threat to performing a stable approach. Runway change or late runway allocation can also lead to an unstable approach. Glide paths over 3 degrees (due to terrain or noise considerations) increase the risk of an unstable approach considerably. For example, the approach speed of a fully loaded Boeing 737-900 in gusty conditions on a 3 degrees glide path requires a vertical speed of 900 feet per minute. The Ground proximity Warning System gives an alarm with 1000fpm (the stable approach limit); there is little room for corrections. Even a small tail wind would make a stable approach impossible. Furthermore, each knot of tail wind represents one-knot square more energy to lose on the runway.

Wind and vortices

Another factor is a wind shift during the approach. Wind on the runway might indicate a head wind, whilst during the approach a gradual or sudden (shear) wind shift occurs from tail to head. For example, some airports are known to have a 20-30 knot tailwind in the approach, changing at the very last minute to a headwind during landing. This might be a positive slow shear, but it will make a stable approach extremely difficult to achieve. Preferential runway allocation systems are often based on strict ground wind limits, but vertical shears are rarely taken into account.

Finally, aircraft wake vortices could make a stable approach very difficult to achieve. Although ICAO has produced guidelines for spacing, these are not always sufficient for performing stable approaches. Approach speeds could differ up to 60 knots in modern aircraft. Trying to optimise runway occupancy, ATC often restricts aircraft not to fly at their ideal approach speed, but faster or slower (e.g. 160 knots until the Outer Marker, poses a real challenge for aircraft like the A330). These speeds increase the chance of an unstable approach, increase workload in the cockpit and thus will increase the chance of a runway excursion.

Conclusions and recommendations

Nowadays, computerised and design optimisation to the millimetre without adequate margins leaves no room for stochastic real world variations. When at an unfortunate moment an unexpected situation arises, the chance of a runway excursion is likely.

Pilots and air traffic controllers work together in the same aviation environment with the same goals: safe and efficient flights. So how can ATCOs and ANSPs help pilots to reduce the chance of a runway excursion?

First of all, air traffic controllers should understand precisely all elements of a stable approach. The design of good approach procedures will help pilots perform a stable approach. Good ATC guidance will help the execution of a stable approach.

Secondly, they should understand fully the importance of timely and factual information needed by aircrew for their performance calculations which is in the range of …?. The three / four-dimensional wind and runway friction characteristics are the "biggies" here. Controllers should also realise that runway optimisation, while good for throughput, might have a direct and adverse effect on flight safety.

Finally, rule makers will have to accept that adequate margins are essential to cover for imperfections of the theoretical system. Optimisation in figures after the comma, without these margins, might look good on paper, but disrespect the dynamic forces of nature and the human being.

Unless these three recommendations are respected, it is reasonable to conclude that runway excursion accidents will continue to disrupt airport operations and to cause casualties. We do not want that; it is therefore imperative that air traffic controllers and pilots work closely together to prevent runway excursions.

Some hidden dangers of tailwind

by Gerard van Es, NLR-Air Transport Safety Institute, Amsterdam, The Netherlands.

While inbound to Southampton (UK), the crew of a Cessna Citation had been given the weather as surface wind 040deg/12kt, thunderstorms, the runway is very wet. Ten minutes later they were advised that the visibility was deteriorating - 'now 2,000m in heavy thunderstorms.'

'Shortly after this they were advised 'entirely at your discretion you may establish on the ILS localiser for Runway 20 for visual break-off to land on Runway 02." The captain accepted this offer. He then asked the co-pilot for the surface wind and was told that it was 040deg but that earlier it had been 020deg/14kt. The flight was then cleared for a visual approach for Runway 02. Meanwhile however, the captain had decided to land on Runway 20 and told the co-pilot this. He later reported that he had decided to land on this runway because he could see the weather at the other end of the runway appeared 'very black' and he had mentally estimated that the tailwind component would be about 10kt (the operating Manual gives a maximum tailwind component of 10kt.) The co-pilot then advised ATC that they would be landing on Runway 20. The controller replied 'you'll be landing with a fifteen knot tailwind component on a very wet runway.' This message was immediately acknowledged by the co-pilot with the words 'roger, copied, thank you.' However, the co-pilot made no comment to the captain about the tailwind component and did not raise the question of continuing to land on Runway 20 with him. The aircraft touched down normally and within 5kt of the target speed but, given the tailwind and the wet runway, it was not possible to stop it on the remaining runway length and the aircraft overran the end of the runway. After coming to rest, the aircraft caught fire and was destroyed.

Gérard van Es

works as a senior advisory flight safety and operations for the NLR-Air Transport Safety Institute - Amsterdam, the Netherlands.
He is currently involved in the European working group for the prevention of runway excursions.

Tailwinds are very welcome to pilots when they are flying from A to B since it helps shorten the flight time. However, closer to the runway they can be anything but welcome.

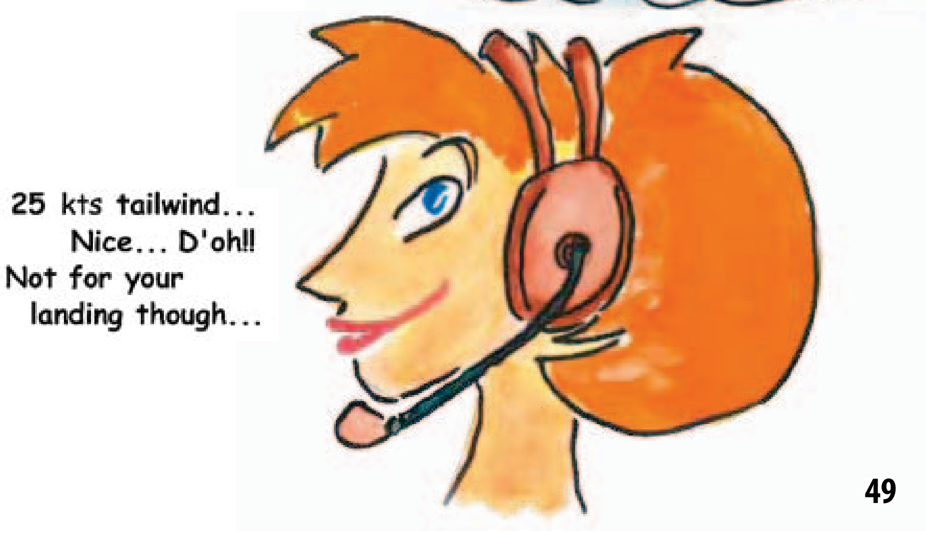
Tailwinds are very welcome to pilots when they are flying from A to B since it helps shorten the flight time. However, closer to the runway they can be anything but welcome. Even a bit of tailwind can be a hazard. Tailwind conditions can have adverse effects on aircraft performance and handling qualities in the critical flight phases of takeoff, approach and landing. Tailwind, for instance, increases the required runway length to land on or takeoff from. To the pilot, it is therefore important to have timely and accurate wind information. Controllers are an important link in this process. However, in the end the pilot remains fully responsible whether to takeoff or land. In the above example, the controller offered a favourable runway regarding tailwind. However, the captain decided to land on another runway. The controller in this case informed the crew that they were landing with a 15 knots tailwind on the other runway (remember most civil aircraft are certified for 10 knots tailwind which can sometimes be increased to 15 knots if the airline asks the manufacturer, both on a dry runway). In this example, the runway was wet which normally reduces the tailwind limit. The controller also informed the crew about the very wet runway. Nevertheless, the crew continued their landing on the unfavourable runway. Should the controller have been clearer in his message when he informed the crew about the high tailwind and wet runway? It is not the controller's job to decide to land or not. That decision remains with the crew. In this case, the controller gave adequate warnings which the crew did not react to.

Pilots often complain about unexpected tailwinds aloft during the approach. Tailwinds are a contributor to unstable approaches or rushed approaches which themselves have contributed to many landing overruns in the past. The controller obtains the wind readings from anemometers which are positioned close to the runway. Given that these anemometers are normally positioned on a 10-m tower, the wind measurements derived from them are not representative of the conditions aloft. There are normally significant differences between surface winds and the winds during approach. It is therefore no surprise when a pilot complains to the controller that the winds aloft were different from those advertised at the surface. It is not currently possible for the controller to have more accurate wind reading that also apply aloft.

EDITORIAL NOTE:

More detail on the accident example used above, including the Official UK AAIB Report of the investigation, may be found at:

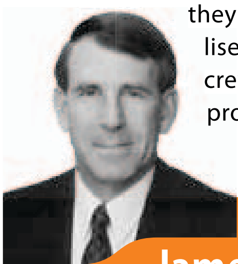
http://www.skybrary.aero/index.php/C550,_Southampton_UK,_1993_(RE_HF_WX_FIRE)



The role of ATM in reducing the risk of runway excursions

By Jim Burin, Flight Safety Foundation. Runway excursions are the most common type of accident in commercial aviation. One in three jet accidents is a runway excursion, and one in four turboprop accidents is a runway excursion.

The definition of a runway excursion is when an aircraft on the runway surface departs the end or the side of the runway. About one in every five excursions occurs on takeoff. There are two types of runway excursions, veer offs (going off the side of the runway) and overruns (going off the end of the runway). All organisations that are involved in aviation play a role in reducing the risk of runway excursions. These include aircraft manufacturers, operators, airports, regulators, and air traffic management (ATM). ATM plays a significant role in any issue dealing with the runway and runway safety. ATM has two primary roles in reducing the risk of landing runway excursions. First, they need to provide stabilised approach assistance to crews. Second, they should provide aircrews timely and



James M. Burin

has 42 years of aviation experience and 34 years of experience in the aviation safety field. Jim retired from the Navy as a captain after 30 years of distinguished service. He was the Commanding Officer of an attack squadron and a Carrier Air Wing Commander. As the Director of Technical Programs of FSF his duties include organizing and overseeing safety committees and managing safety related conferences and research.

Recommended Elements of a Stabilised Approach

All flights must be stabilised by 1,000 feet above airport elevation in instrument meteorological conditions (IMC) and by 500 feet above airport elevation in visual meteorological conditions (VMC). An approach is stabilised when all of the following criteria are met:

1. The aircraft is on the correct flight path
2. Only small changes in heading/pitch are required to maintain the correct flight path
3. The aircraft speed is not more than VREF + 20 knots indicated airspeed and not less than VREF
4. The aircraft is in the correct landing configuration
5. Sink rate is no greater than 1,000 feet per minute. If an approach requires a sink rate greater than 1,000 feet per minute, a special briefing should be conducted
6. Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined by the aircraft operating manual
7. All briefings and checklists have been conducted
8. Specific types of approaches are stabilised if they also fulfil the following: instrument landing system (ILS) approaches must be flown within one dot of the glideslope and localiser; a Category II or Category III ILS approach must be flown within the expanded localizer band; during a circling approach, wings should be level on final when the aircraft reaches 300 feet above airport elevation
9. Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilised approach require a special briefing

An approach that becomes unstabilised below 1,000 feet above airport elevation in IMC or below 500 feet above airport elevation in VMC requires an immediate go-around.

Source: Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force (V1.1 November 2000) the most accurate information available concerning winds, weather conditions, and runway conditions.

Approach and landing is the highest risk phase of flight for all categories of aircraft. Data has shown that stabilised approaches are critical to all aspects of approach and landing accident reduction. A stabilised approach is defined by parameters established by operators that include the intended flight path, speed, power setting, aircraft attitude, sink rate, configuration, and crew readiness. An example of stabilised approach criteria are the ones recommended by the Flight Safety Foundation.

Stabilised approaches are particularly important in reducing the risk of a landing runway excursion. There are several reasons why an approach may be unstable. These reasons can be attributed to the aircrew, the aircraft, ATM, environment conditions, or a combination of these factors. As every pilot knows, ATM can destabilise any approach. For example, late runway changes and "slam dunk" approaches are two ways that ATM can cause an approach to become unstable. The important question is, do the ATM personnel know that these procedures can cause unstable approaches, and thus increase the risk during the approach and landing phase? Even more basic, do the controllers know what a stabilised approach is? Although pilots and controllers constantly work with each other, sometimes they don't fully understand each other's challenges.

An example of this is used in the Flight Safety Foundation's Approach and Landing Accident Reduction (ALAR) program. A major US airline was having an inordinate number of go-arounds at one of its hub airports. After reviewing FOQA data, the airline went to the local ATM organization and reviewed the go-arounds with them. The ATM personnel were not aware that some of the procedures they were using were causing the go-arounds. After a discussion of the issue, the procedures were changed. Also, a formal program was started with regular meetings between the airline and the local ATM personnel. ATM personnel were given simulator sessions with the airlines pilots to become more familiar with the pilots issues during approaches. In addition, the airline pilots went to the local ATM facility and observed the challenges the ATM personnel had to deal with. The result of these actions was the virtual elimination of preventable go-arounds at the airport. There are several similar pilot-controller programs around the world, designed to improve pilot-controller coordination and cooperation. Any program on pilot-controller communication should involve the pilots and controllers in joint meetings and in joint flight/ATC simulator sessions to promote a mutual understanding of each other's working environment. Discussions, for example, could include problems caused by late clearances and last-minute runway changes. In the end, these are challenges that effect both pilots and controllers, and these challenges need to be addressed in order to reduce the risk of runway excursions.

Approach and landing is the highest risk phase of flight for all categories of aircraft. Data has shown that stabilised approaches are critical to all aspects of approach and landing accident reduction.

Editorial note

A controller will not necessarily know exactly what criteria are being applied by each aircraft operator. Perhaps more importantly, they will also rarely know at what height above landing a mandatory 'gate' for application of the stabilised approach criteria has been set – both 500 ft and 1000ft are widely used. It is worth pointing out that, although the example quoted makes a distinction between whether an aircraft is in IMC or VMC in assigning the height of the mandatory gate, many operators do not do that. Also, some have found it useful to have two successive gates, the mandatory or 'must' one and a prior 'should' one, the latter typically set 500 ft higher.

TCAP: an altitude capture enhancement to prevent TCAS RAs

By Paule Botargues, Airbus SAS, Automatic Flight Systems Research, Engineering Department.

The 'Traffic Alert and Collision Avoidance System' – known as 'TCAS' was introduced in the 90's to prevent the risk of mid-air collisions. Today, this safety goal has been reached on a global scale. However, a recurrent side-effect of TCAS introduction can be observed. This side-effect is what we call the 'nuisance' RAs or the operationally 'undesired' RAs, which occur during 1000ft separation level-off manoeuvres. A new Safety Initiative has been launched by Airbus in response to BEA and EUROCONTROL recommendations as well as in response to airline requests to solve this issue.

What is an operationally 'undesired' TCAS RA?

What we call an operationally 'undesired' RA is an RA, which occurs during 1000ft level-off manoeuvres while everything is correctly done by the crew with regards to operations and clearance.

These 'undesired' RAs can be characterised by the following two typical encounter geometries:

- One aircraft (in red on Figure 1) is intending to level-off at a given level while another aircraft (in blue on Figure 1) is already levelled at the adjacent level (1000ft beyond the 1st aircraft intended level)
- One aircraft is climbing to level-off at a given level while another aircraft is descending to level-off at the adjacent level (1000ft beyond the 1st aircraft intended level) as on Figure 2

We know from EMOTION-7[1] and ASARP[2] European projects that this type of operationally 'undesired' RAs represent more than 50% of all RAs triggered by TCAS in Europe, and even more than 2/3 of RAs for some

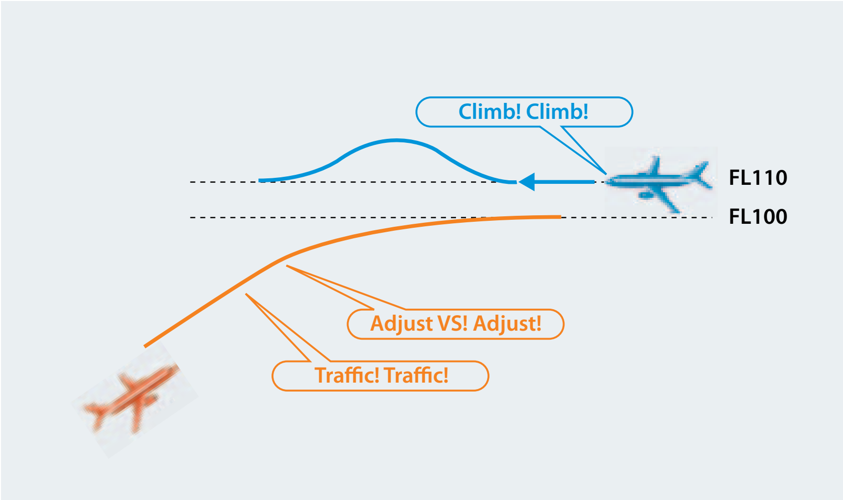


Figure 1 – 'Undesired' TCAS RAs occurring during a single 1000ft level-off manoeuvre

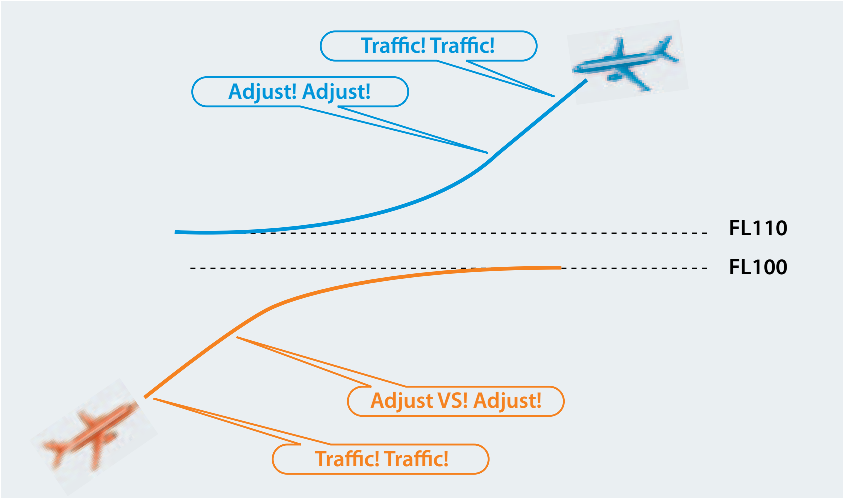


Figure 2 – 'Undesired' TCAS RAs occurring during a double level-off manoeuvre

1- EMOTION-7: European Maintenance Of TCAS II logic version 7.0 - Project commissioned by EUROCONTROL to provide the Agency with the adequate tool and structure to minimize any possible risk associated with the ACAS II implementation in Europe (Jan 2000 - Dec 2002).

2- ASARP: ACAS Safety Analysis post-RVSM Project – Project commissioned by EUROCONTROL to investigate the safety of ACAS following the introduction of RVSM in Europe (Oct 2004 – May 2006).

major European airlines which use to frequently operate very high density TMAs like Paris or London.

Although these RAs do not imply a 'real' collision risk (as far as aircraft intentions are to level-off), they remain very stressful alerts and above all, they impose - by procedure - an avoidance manoeuvre to both aircraft, leading to unnecessary deviations from initial trajectories and to traffic perturbations.

Let's take the example of an A320 (medium weight/CG, selected speed 300kt) climbing to FL130 with a vertical speed of 2800ft/min, while an A340-600 (light weight / medium CG, selected speed VMO-20kt) is descending to FL140 with a vertical speed of 2200 ft/min as shown on Figure 3. In such an encounter, TCAS system will trigger a TA at FL116 in the A320 and simultaneously a TA at FL153 in the A340-600 followed by an RA at FL123 in the A320 and an RA at FL147 in the A340-600.

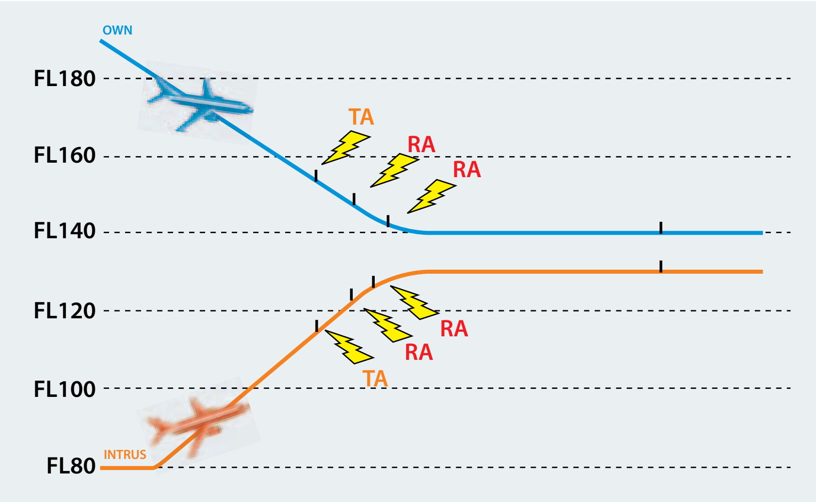


Figure 3 – Example of nuisance TCAS alerts occurring during a double level-off manoeuvre

Recommendations to prevent these RAs

Several recommendations have been made to prevent these 'undesired' RAs. The first of them directly addresses the pilots and consists of reducing the vertical rate when approaching an assigned altitude or a flight level, when pilots are aware of traffic converging in altitude. Indeed, this preventive action enables us to limit the vertical convergence between aircraft and thus to prevent passing TCAS alert triggering thresholds.

As shown in Table 1, we can observe that the preventive rates to apply lightly vary depending on who is expressing the rule. For example, in PANS-OPS Doc. 8168, ICAO recommends adopting a rate less than 1500ft/min throughout the last 1000ft of climb or descent to the assigned altitude when the pilot is made aware of another aircraft at or approaching an adjacent altitude.

In the Airbus FCOM, we recommend that pilots limit the vertical speed to 1500 ft/min during the last 2000ft of a climb or descent, especially when they are aware of traffic that is converging in altitude and intending to level off 1000ft above or below the pilot's assigned altitude.

	Vz	Dist. to level
AI FCOM	1500 ft/min	2000 ft
FAA	500-1500 ft/min	1000-2000 ft
ICAO	1500 ft/min	1000 ft
DLH	2000 ft/min	2000 ft
	1000 ft/min	1000 ft
EUROCONTROL ACAS and RVSM Programs	1000 ft/min	1000 ft
Swiss regulation	1500 ft/min	1500 ft

Table 1 – Recommendations to prevent 'undesired' TCAS RAs

This last recommendation meets FAA one within AC 20-151A (appendix A section III), which advises to reduce the vertical velocity to a rate between 500 and 1500ft/min, when approaching an altitude between 1000 and 2000ft above or below the altitude assigned.

As a matter of fact, those recommendations are rarely applied. Some pilots confess it is difficult to apply as it requires a lot of anticipation. As a result, there is still a significant number of undesired RAs observed during 1000ft level-off manoeuvres.

TCAP: an altitude capture enhancement to prevent TCAS RAs (cont'd)

Another kind of recommendation – more "medium-term" – has been expressed by BEA following a mid-air incident in March 2003, where a wrong response to an "ADJUST V/S" RA was observed in the context of a 1000ft level-off encounter. BEA requested aircraft manufacturers to study the capability to take into account TCAS alert triggering thresholds into their altitude capture laws.

This recommendation has been followed by EUROCONTROL within the ACAS Bulletins and by several airlines who requested a modification of the altitude capture control laws with an earlier reduction of the vertical rate to prevent such recurrent undesired RAs.

The Airbus Solution: TCAP function

In response to these requests for improvement, Airbus has launched the feasibility study of a new system called 'TCAS Alert Prevention' or 'TCAP'.

The objective of this new 'TCAP' feature is twofold:

1) To reduce the number of undesired TCAS RAs occurring during 1000ft level-off encounters by introducing a new altitude capture law which soften aircraft arrival to an intended altitude when traffic is confirmed in the nearby vicinity.

2) Not to unduly degrade the aircraft performance, in particular in descent, by a premature and excessive reduction of the vertical speed before reaching the altitude target, when it is not justified.

TCAP activation logic is based on the Traffic Advisory (TA) triggered by TCAS system, which clearly confirms the presence of traffic in the aircraft vicinity. This triggering condition is associated to a set of necessary pre-conditions including:

- The Auto Pilot and/or the Flight Director must be engaged,
- The aircraft is converging towards its selected altitude,
- The distance to the selected altitude at the time of the TA is lower than what we called the 'TCAP availability threshold' DZ_{avail} (see below).

The concept of a 'TCAP availability threshold' has been introduced in order to limit TCAP activation to the only TAs corresponding to our targeted encounter geometries, i.e. to the 1000ft level-off encounters.

To avoid any TCAP activation upon a TA occurring in other circumstances (e.g. far from selected altitude), TCAP availability threshold DZ_{avail} has been defined as the upper distance from the selected altitude where a TA can occur with an intruder capturing the same altitude in the opposite sense (with a 'conventional' altitude capture control law). This DZ_{avail} value depends both on the aircraft vertical speed at the time of the TA and on its altitude.

For example, with a vertical speed of +3000ft/min at FL130, DZ_{avail} is around 4000ft. This means that in case of a TA, TCAP will activate if the aircraft intend to capture a flight level lower than FL170. TCAP will be inhibited if the aircraft intend to capture a flight level greater than FL170.

Upon TCAP activation at TA:

- If the aircraft is initially in a vertical guidance mode other than the altitude capture mode (for example in a climb or a descent mode), the vertical mode automatically reverts to the altitude capture mode (ALT* for Airbus HMI) with the new TCAP altitude control law active ($ALT*_{TCAP}$ control law).
See figure 5.

- If the vertical mode is initially the altitude capture mode (ALT* with the conventional altitude capture control law active), the vertical mode remains the altitude capture mode but with the new $ALT*_{TCAP}$ control law active. The flight mode annunciator, 'ALT*' remains displayed.
See figure 6.

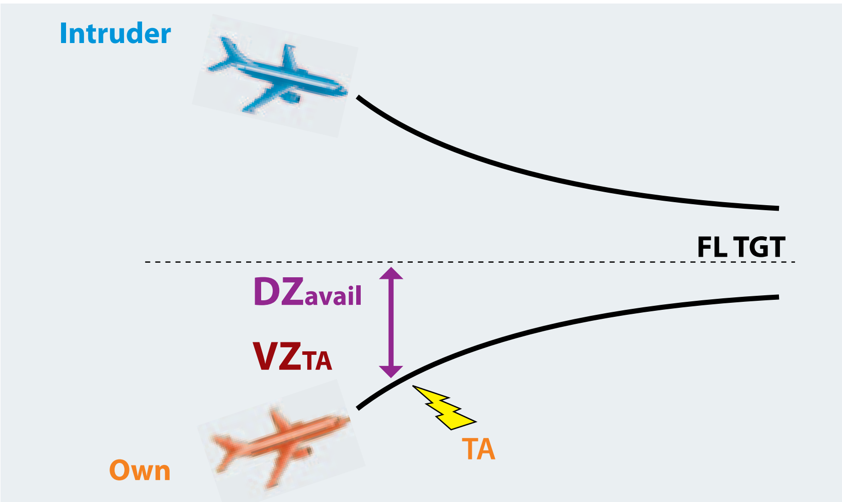


Figure 4 – TCAP availability threshold DZ_{avail}

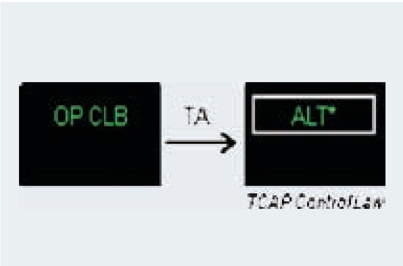


Figure 5 – FMA upon TCAP activation when initially in OP CLB

Figure 6 – FMA upon TCAP activation when initially in ALT*

Once activated, the ALT*$_{TCAP}$ control law remains active until the end of the capture (with ALT* mode engaged), even if the triggering TA ceases. This is to avoid triggering a new TA.

Finally, it is important to note that TCAP activation has no impact on the lateral trajectory and associated lateral guidance mode as well as no impact on Auto-Pilot, Flight Director and Auto-Thrust engagement status.

New TCAP ALTITUDE capture control law (ALT*$_{TCAP}$)

ALT*$_{TCAP}$ control law objective is to acquire and hold one or several consecutive vertical speed targets until the aircraft reaches its intended altitude by resuming a classical 0.05g parabola profile.

When in ALT*$_{TCAP}$ control law, a vertical load factor of 0.15g is applied to ensure a rapid reduction of the vertical speed, and therefore a more efficient prevention of the RAs. It also gives a reliable sensorial feedback to the crew to indicate TCAP function activation if ALT* mode was previously engaged.

ALT*$_{TCAP}$ vertical speed targets (VzTGT) have been defined so as to efficiently prevent 'undesired' RAs while not to unbearably increase the altitude capture phase duration, based on an optimisation algorithm applied to 100.000 encounters.

When TCAP is active, ALT*$_{TCAP}$ vertical speed targets are computed in decreasing sequence and refreshed as long as the TA is active, so as to comply with the operational requirement to "kill" the triggering TA for pilot confidence in TCAP effect.

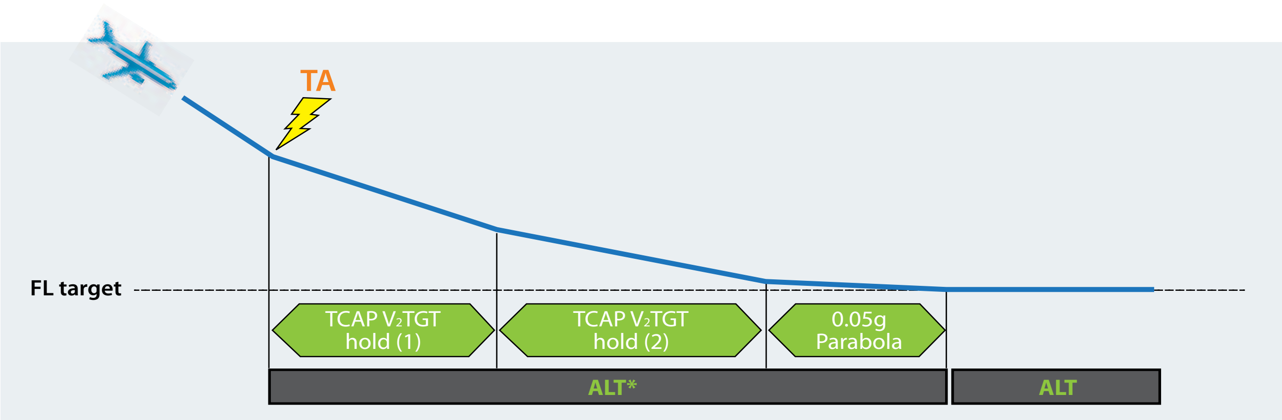


Figure 7 – TCAP Profile

TCAP: an altitude capture enhancement to prevent TCAS RAs (cont'd)

In the case of a TA occurring farther than the last 2000ft from intended altitude (also called "early-TA"), the preliminary TCAP vertical speed target is the function both of the current aircraft vertical speed at the time of the TA (VzTA) and of the distance to the targeted altitude. Its value is comprised between 1500ft/min and Vz_{TA} (assuming Vz_{TA} > 1500 ft/min). When entering the last 2000ft from targeted altitude, the vertical speed target automatically becomes 1500ft/min till the final capture (see Figure 8).

In the case of a TA occurring within the last 2000ft of an altitude capture, the TCAP vertical speed target is the function of the distance to the targeted altitude at the time of the TA. Its value is comprised between 1200ft/min and 1500ft/min (see Figure 9).

The average impact on the altitude capture time is an increase of 40 seconds, compared to the conventional altitude capture law, remembering that TCAP control law activation is limited to a TA occurrence.

EXAMPLES

"Early-TA" occurring when the aircraft is in descent

The aircraft is descending in OP DES mode when a TA occurs farther than the last 2000ft. The ALT* mode immediately engages with ALT^*_{TCAP} control law active: the rate of descent is then continuously reduced while the TA is active (few seconds) with a vertical load factor of 0.15g. Once the TA is off, the vertical rate is frozen on current vertical speed target (>1500ft/min) until reaching the last 2000ft where the vertical speed target becomes 1500ft/min.

TA occurring during an altitude capture (in ALT*)

The aircraft is performing an altitude capture on the conventional 0.05g parabola capture profile (ALT* mode) when a TA occurs. The ALT^*_{TCAP} law automatically activates to quickly reduce the rate of descent, shortcutting the parabola with a vertical load factor of 0.15g (ALT* mode remains engaged).

The rate of descent is continuously reduced while the TA is active (a few seconds). Once the TA is off, the vertical rate is frozen on the current vertical speed target (1300ft/min) until the end of the capture.

3- INCAS: INteractive Collision Avoidance Simulator: EUROCONTROL tool allowing to simulate encounters and resulting TCAS alerts (Input = aircraft trajectories / Output = TCAS alerts)

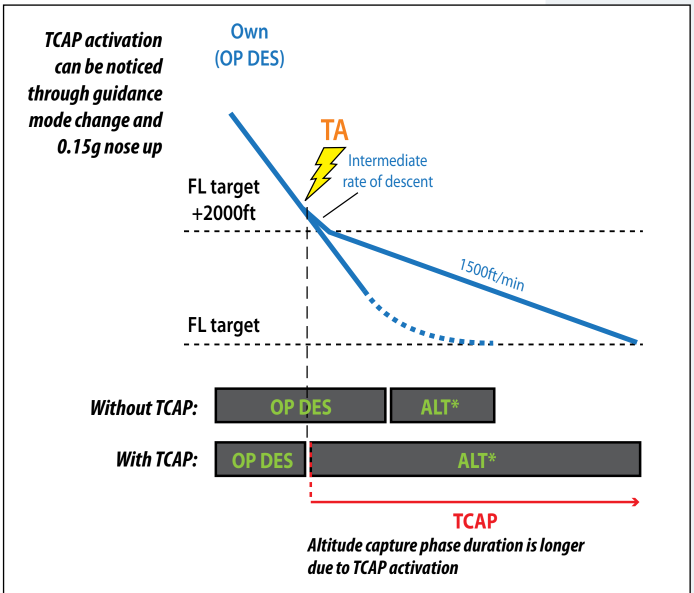


Figure 8 – 'Early-TA' occurring when the aircraft is in descent

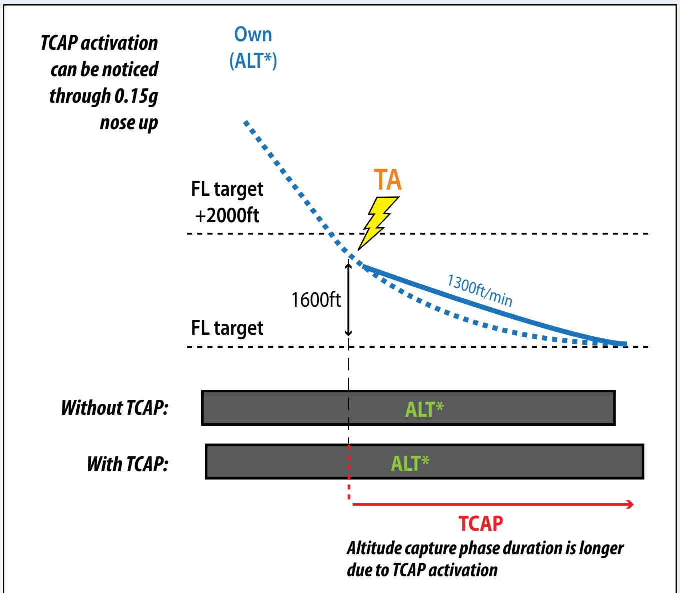


Figure 9 – TA occurring during an altitude capture

Expected benefits

A performance assessment has been carried out thanks to EUROCONTROL INCAS³ tool coupled to Airbus simulation tools in order to measure the benefits of the new Airbus TCAP solution in terms of prevention of 'undesired' TCAS RAs.

For that purpose, several hundreds of encounters, single level-off and double level-off ones, at several flight levels with random initial vertical rate conditions, were tested.

The resulting performance is significant - not to say optimal - with 100% of 'undesired' RAs prevented among the overall simulated cases. Based on this very exhaustive assessment, Airbus is very confident about TCAP efficiency in the current airspace environment.

Another very relevant result observed is the following: only one aircraft of the encounter needs to be equipped with TCAP to allow RAs prevention on both aircraft (see Figure 10).

As far as 'undesired' RAs represent more than 50% of the totality of RAs produced by TCAS system and as far as we anticipate a huge efficiency of TCAP on this RA family, we can assume a major effect on the global airspace perspective with significantly fewer RAs and the following associated outcomes:

- **For the crew:**
  less stress due to RA situations,

- **For ATC:**
  fewer unnecessary traffic perturbations owing to 'undue' avoidance manoeuvres.

Finally, TCAP solution will efficiently contribute to alleviating the crew workload. Pilots will not have to anticipate the FCOM recommendation to prevent 'undesired' RAs any longer, knowing they are flying an aircraft equipped with the TCAP system, they will just have to monitor the Auto Pilot or the Flight Director adopting the proper strategy in the event of a TA.

Paule Botargues

works in the Engineering Automatic Flight System Department of AIRBUS France. She is in charge of the multi-program development of the AP/FD TCAS Mode and also of research activities for the auto flight system.

Next steps

This new TCAP altitude capture enhancement will be available on A380, A350 and on fly-by-wire aircraft families in the near future. The certification targets are anticipated between end 2011 and mid 2013 depending on the aircraft type.

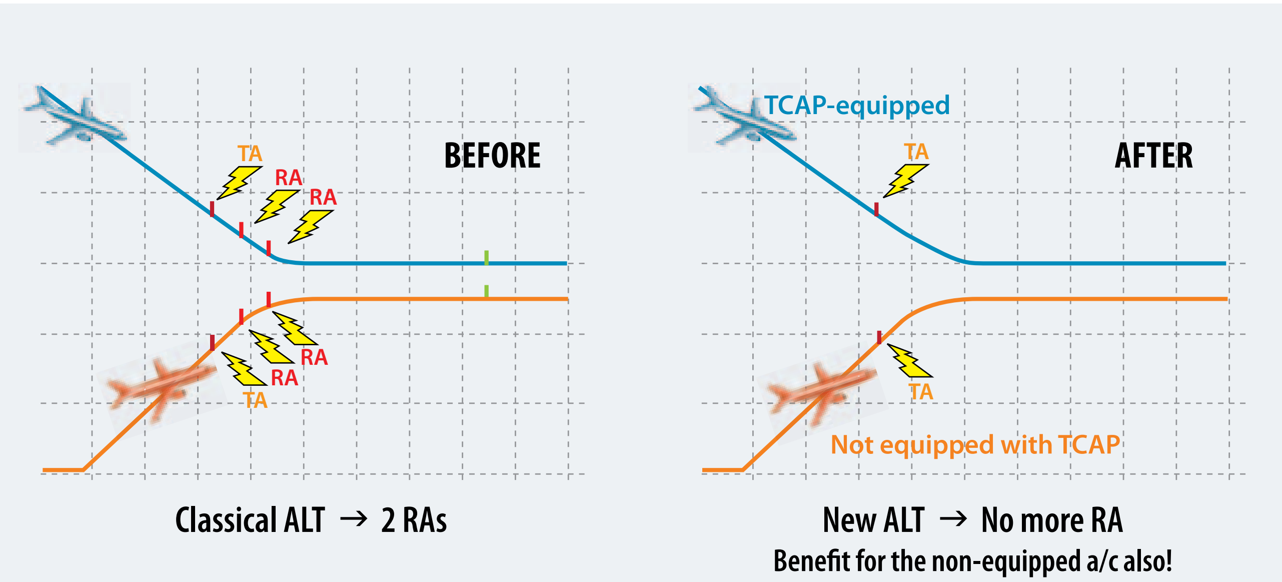
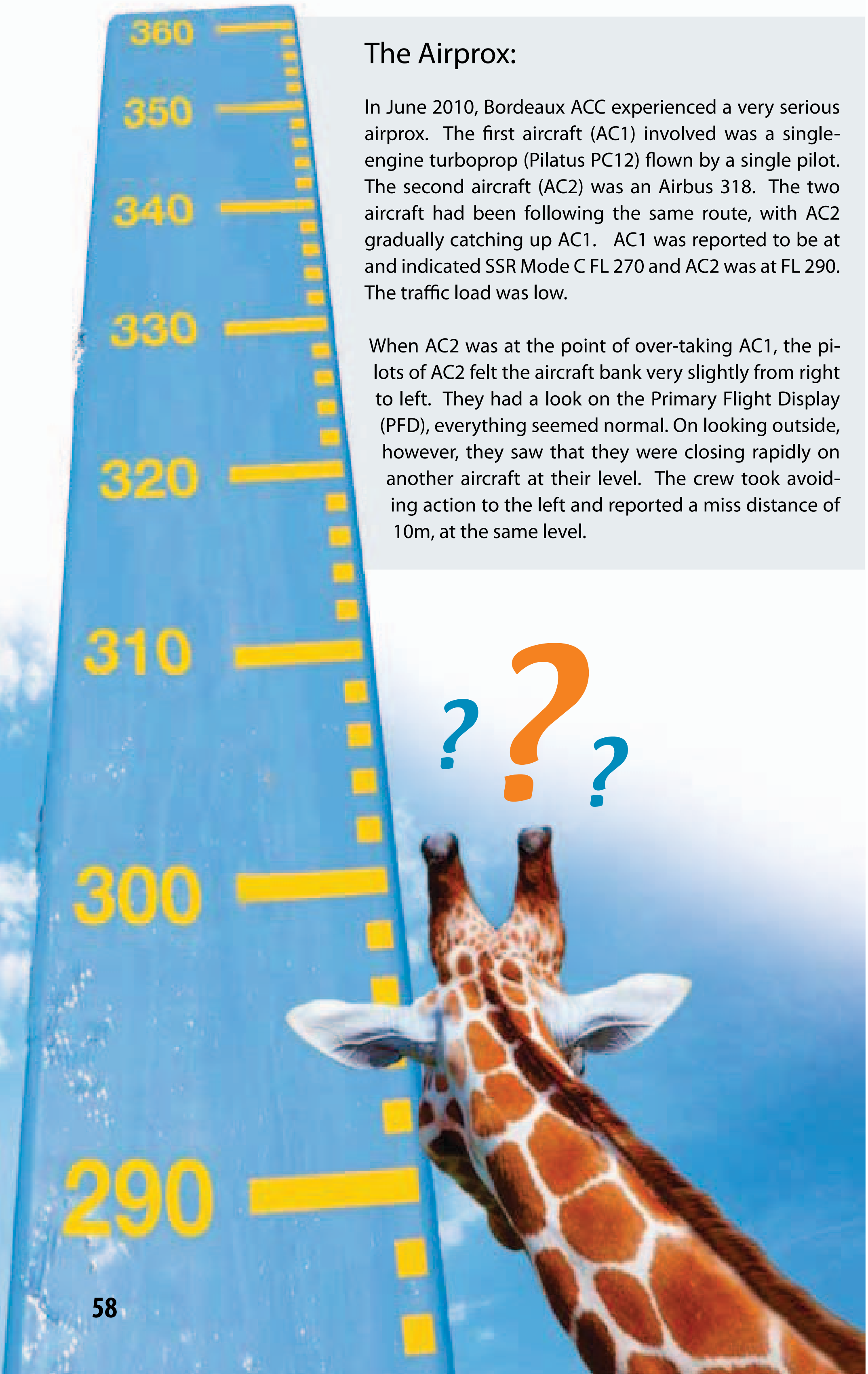


Figure 10 – TCAP benefits on a double level-off encounter

AIRPROX - Altimeter System Error
What's my level?

By Chantal Bonnet - DSNA



The Airprox:

In June 2010, Bordeaux ACC experienced a very serious airprox. The first aircraft (AC1) involved was a single-engine turboprop (Pilatus PC12) flown by a single pilot. The second aircraft (AC2) was an Airbus 318. The two aircraft had been following the same route, with AC2 gradually catching up AC1. AC1 was reported to be at and indicated SSR Mode C FL 270 and AC2 was at FL 290. The traffic load was low.

When AC2 was at the point of over-taking AC1, the pilots of AC2 felt the aircraft bank very slightly from right to left. They had a look on the Primary Flight Display (PFD), everything seemed normal. On looking outside, however, they saw that they were closing rapidly on another aircraft at their level. The crew took avoiding action to the left and reported a miss distance of 10m, at the same level.

What happened before?

After take-off, in contact with Skyguide, when AC1 was stable at FL100, the pilot reported a discrepancy between the two altimeters fitted on the aircraft. The pilot asked ATC to check that the aircraft was at FL 100 and this was confirmed by the controller.

AC1 was then transferred to Marseille ACC. The pilot did not report any altimeter problems while in contact with Marseille ACC.

AC1 was then transferred to Bordeaux ACC with SSR Mode C indicating FL270. This was confirmed and verified on first contact. A few minutes later, the pilot of AC1 reported to ATC that he had a discrepancy in the displayed altitude on his two altimeters: one indicated FL270 and the other FL290. He asked ATC if they could check his altitude if he put his Mode C on Standby. At that moment, there was no other traffic in the vicinity of AC1, and so there was no need to effect any horizontal separation. The controller, aware that military control centres were equipped with primary height-finding radar able to evaluate an altitude, decided to check AC1's altitude with his military colleagues.

This initiated a complex co-ordination sequence involving 3 intermediaries about a request to check AC1's altitude by a source other than that used to derive the Mode C data being displayed to the Bordeaux controller. During this period, AC2 made its first contact with the Bordeaux controller and was cleared to FL 290. After approximately another 3 minutes, the Bordeaux controller received confirmation from the military

Further Reading:

- **ICAO Annex 6 – Operation of Aircraft**
- **SKYbrary articles:**
  - Altimeter System Error
  - Height Monitoring Units
  - RVSM
  - Aircraft Technical Equipment
  - EFIS
  - Altitude Alerter
  - EU OPS

that AC1 was at exactly FL 270! However, it later transpired that the source used for the cross-check was the same as that used by the Bordeaux controller (i.e. SSR derived Mode C data). Unaware of this and believing AC1 to be at FL270, the controller still did not consider it necessary to build in any horizontal separation between AC1 and AC2 which was by then at FL290 and following AC1 on the same route.

The airprox occurred ten minutes after the (false) cross-check. Neither STCA nor TCAS was triggered!

Finally, ten minutes after the event, the pilot of AC1 manually selected the second altimeter for Mode C and the aircraft was displayed at FL290 on the radar screens.

Analysis:

The investigation and analysis of the incident by BEA (French AIB) and DSNA identified a number of key points:

- The altimeter failure was due to a leak in the static circuit No. 1 (pilot's circuit). This leak was located on a short plastic connector that links the static circuit with the cabin differential pressure indicator.
- There is no set procedure for the PC12 to help pilots determine which altimeter displays the most reliable information in these circumstances.
- There is no ICAO procedure related to this situation (i.e. when the pilot is unable to determine his altitude due to discrepancy in altimeter readings), which is completely different from controllers verifying Mode C indications.
- The pilot did not declare any state of urgency (the flight had been controlled with a critical altitude error for more than 35 minutes in airspace that is usually very busy).
- Some primary height-finding radar can evaluate the altitude of a flight but this information is not accurate enough to be used for separation (the error is generally more than 2000 ft).
- Ground-to-ground communications can be complex. Safety-related information must be passed on accurately from one agency to another or from one sector to another.
- Altimeter System Error can negate the benefits of safety nets such as STCA and ACAS.
- ATCOs and pilots can be 'surprised' if they do not maintain an understanding and/or knowledge of how certain ground and airborne systems work and how they may interact with each other.

Mitigations and lessons learned:

- ATC relies on the altitude/height information provided by the pilot/aircraft systems for the safe provision of ATS. However, there is no independent means available to determine the veracity of the information. When a pilot asks a controller to confirm his/her altitude, because there is a discrepancy in altimeter readings, this should not be considered as a routine situation.

What can be done by ATC when the pilot confirms the problem?

- Establish horizontal separation.
- Ask the pilot to stop Mode C.
- Inform the pilot that it is not possible to determine his/her altitude.
- Inform other sectors/centres.
- Depending on the severity of the situation:
  - Ask the pilot to select Mode A 7700.
  - Provide flight assistance – if practicable arrange an escort aircraft, help the pilot to remain in VMC.

Internally, important efforts have been made to learn lessons from this incident and provide feedback to ATCOs.

During the period 2009/2010, two other occurrences when pilots informed ATCOs that they were not sure about their altitude were reported. However, unlike the incident described above, in those particular cases, the displayed altitudes turned out to be correct.

Chantal Bonnet

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EDITORIAL NOTE

One important point in this account insofar as it has wider implications for us all is the number of (serviceable) barometric altimeters on the flight deck. Some small aircraft like the PC12 will often only have two even though they are sometimes flown IFR in Controlled Airspace, whereas larger aircraft will have three. Having three altimeters means that, in the event of the malfunction of a single instrument, cross checking will disclose the problem and the majority reading (two out of three the same) will easily determine which one is unreliable and can be ignored, with one of the serviceable ones selected as the height encoding source. ATC do not need to know.

SKYbrary downloads

If you need to find out something about aviation safety, we suggest you go first to **www.skybrary.aero**. It doesn't matter whether you are a controller, a pilot or a maintenance engineer, SKYbrary aims to have either the answer you are looking for or a direct route to it.

SKY brary

If by any chance you can't find what you want, please remember that **SKYbrary** is a dynamic work-in-progress which needs continuous user feedback and benefits from user support. Be sure to tell the **SKYbrary Editor** about any difficulty you may have had making it work for you. If you can directly help us by identifying material we could use or even fill a gap by writing some content yourself then please tell us too!

We aim to provide wide coverage through both original articles and, especially, by hosting the best of what's already been written so that a wider audience can access it more easily in one place.

SKYbrary is also the place where you can access:

- all the documents of the **Flight Safety Foundation Operator's Guide to Human Factors in Aviation**
- the largest collection of selected official **accident & serious incident reports** from around the world anywhere in one place online
- an expanding facility to **search ICAO document text.**

In future, we will be reprinting a **SKYbrary** article in each issue of **HINDSIGHT**. This time we have chosen something which can affect us all – **Wind Velocity Reporting**.

Wind velocity reporting

Description

This article summarises the origin of wind velocity measurements made at airports and communicated to aircraft to assist their safe take off and landing. It also provides some guidance on how this information should be applied by flight crew, which concerns aircraft performance calculations, operating within prescribed AFM limits and the tactical handling of the aircraft during take off and landing.

Article Information

Category: Runway Excursion

Content source: SKYbrary

Content source: EUROCONTROL

What is wind velocity?

Velocity is a vector, which simply means that it is defined by two parameters, speed and direction. A specification of wind velocity therefore requires that both wind direction and wind speed are given. Wind direction is always given as a radial measure in degrees stating the direction from which the wind is blowing. Wind speed may be given in either knots (nautical miles per hour) or metres per second depending upon the procedures of the State concerned.

Caution: Many references to wind measurement from non-expert sources equate 'wind velocity' with 'wind speed' and therefore typically refer to 'wind velocity and direction' which is incorrect. The Flight Safety Foundation Notes listed under Further Reading below are examples of this error.

Wind velocity and aircraft safety

Whilst it is probably true to say that the importance of taking appropriate account of wind velocity during the take off and landing of an aircraft is appreciated by all aviators and air traffic controllers, problems arise because unless it is completely calm, it is impossible when near the ground to know the actual wind velocity of an aircraft at a given time and location. Using wind velocity information is therefore a matter of:

- Understanding exactly what velocity is being provided
- Using the information appropriately

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On-board displays of wind velocity

Flight deck displays of 'instant' wind velocity based on onboard computations are now quite accurate when instant variation is not required, especially away from the ground, but their usefulness for assisting the execution of a safe touchdown, landing roll or take off roll is often very limited, both for practical and computational reasons. Updating of on-board readouts of wind velocity depends on the system which generates them. FMS wind is the most accurate, because it is based on changes GPS or DME/DME position, but it may only be re-calculated every 30 seconds. Wind velocity based upon an INS is often calculated as much as 10 times per second but the result is less precise. The net effect is that neither have real value near or on the ground.

Location of airport wind sensors

There is usually more than one sensor position but all will measure the wind velocity at the standard height of 10 metres above the surface, which is the internationally accepted meteorological definition of 'surface wind' designed to eliminate distortion attributable to very local terrain effects. Any sensor will be sited so as to provide a representative indication of the instantaneous wind velocity in the immediate area around it. The exact sites of wind sensors should be indicated on relevant aerodrome chart in the State AIP. At most airports used for significant commercial or military air traffic, there will be a least one sensor positioned to the side of any runway at the each end in the vicinity of the touchdown zone (TDZ) and there will probably also be at lease one other sensor somewhere in the central area of the defined airside zone. Depending on where this 'general' sensor is and on the relative complexity of the airport layout, there will often be additional sensors adjacent to the mid-point of each runway.

Variation in wind velocity

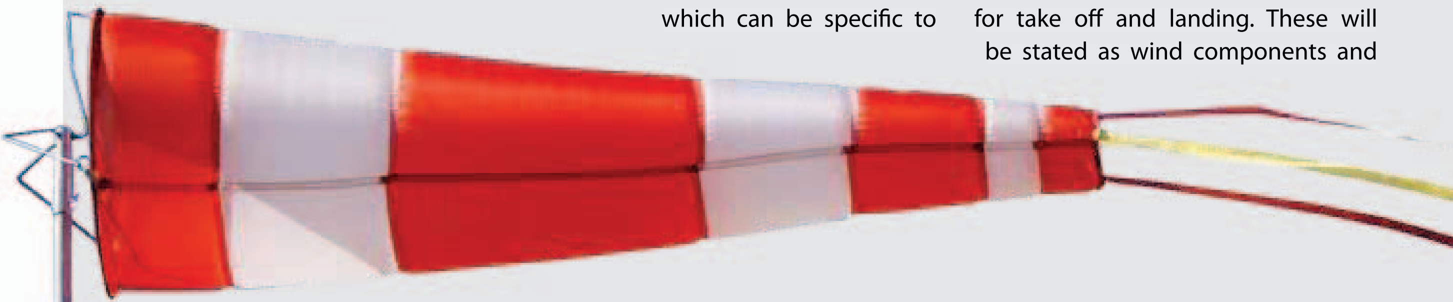
Unless the wind is completely calm, wind velocity rarely remains the same for very long and the extent of the variation in both speed and direction is likely to be directly proportional to the mean wind speed, because the effect of terrain friction upon the characteristics of the wind blowing across it increases as wind speed increases. Clearly, this effect will be greatest at airports situated in areas of uneven terrain or with significant obstacles affecting the degree of low level mechanical turbulence over particular parts of the aerodrome when particular general wind directions prevail.

The prescribed requirements for the reporting of gusting wind speeds and for reporting more than a specified amount of variation in wind direction are contained in ICAO Annex 3 and are reflected in the procedures for METAR observations. However, the variation in wind speed and in wind direction are monitored and used independently and from a practical perspective, interpreting the potential extreme wind velocities is therefore likely to be difficult. However, in respect of wind speed, it is generally accepted that although the gust ratio - the ratio of the maximum gust to the mean wind speed - may frequently reach 2, only rarely will it exceed 3 even in very strong wind conditions.

METAR wind velocity

Wind velocity in a METAR is stated solely as the measured or estimated mean of each component over the 10 minutes prior to the time of issue of the METAR unless there are significant variations during this 10 minute period. For direction, this means 60 degrees or more of arc but less than 180 degrees provided that the mean speed during the previous 10 minutes has been more than 3 knots. In the case of speed, variations from the mean wind speed (both above and below it) are reported when the variation from the mean speed has exceeded 10 knots. Such variations are expressed as

Wind velocity reporting



the maximum and minimum speeds attained and must also be included if the maximum wind speed in a 10 minute period has exceeded the 2 minute average wind speed at the same location in that period. Any gust value which has occurred in the most recent two minute period will, of course, also be part of the calculation of average wind speed

Wind direction is recorded in degrees true. Whatever runway(s) is (are) in use, the wind velocity for the METAR is normally taken from one designated anemometer.

ATIS wind velocity

ATIS wind velocity is latest two minute average. The wind direction broadcast is given in degrees true the wind mean speed will be supplemented by the value of the highest and lowest gusts within the 10 minutes prior to issue time if either exceeds the METAR-specified minimum difference increment away from the mean.

Updating of ATIS broadcasts between any regular change times because of wind velocity changes is usually made only if the wind direction changes by more than 30 degrees or the 2 minute average wind speed changes by more than 5 knots over a five minute interval.

ATC wind velocity reports

Display of wind velocity information to ATC at major airports usually allows at least the reporting by RTF of both the 'average wind' - that over a two minute period updated every minute - and 'instant wind' - the value at that exact time. The latter is usually used only where high wind speeds and their associated greater fluctuations in both speed and direction prevail. ATC may proactively initiate such 'wind checks' or this action may be requested by a flight crew. Whilst the ATC TWR at most international and major domestic airports will nowadays have digital displays of wind velocity which can be specific to sensor site or integrated from several sites and can show a selection of trend and extremes data, smaller airports may still be limited to dual and plotted graphical displays for finding out both required broadcast information and additional ad hoc assistance. ATC plain language ad hoc wind directions given during final approach or just prior to or during the take off roll, are likely to be given in degrees magnetic.

Aircraft performance calculations and reported wind velocity

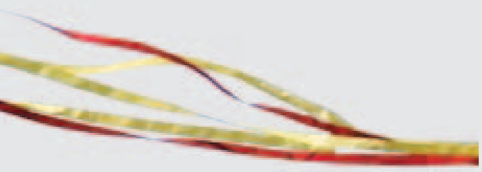
Like any other input to aircraft take off or landing performance calculations, wind velocity will be the (average) figure available prior to taxi out or top of descent. This means that while allowances are made in performance tables or equivalent computer programmes for a certain amount of variation in the inputs, any change in the wind velocity data used which may affect the validity of the calculation for the runway case concerned, must lead to a recalculation.

Applying wind velocity reports to AFM limitations

An AFM or Operations Manual will always contain maximum wind speeds for take off and landing. These will be stated as wind components and will cover the crosswind, tailwind and head wind cases. Instant or two minute winds given by ATC will need to be converted into the applicable wind components by the flight crew and checked against the stated limitations. A suitable graphical display can be used by PM to read the received ATC figures if no automated conversion is available. In all cases, the apparent 'general situation' including any stated or apparent trend, is the key to using this information. Flight crew need to remember that ATC wind velocity information provided during take off or landing at times of high wind speed has to be intelligently interpreted rather than rigidly applied. It is also important to note that maximum wind components in the AFM are invariably dependent on the dry runway case, with more restrictive figures usually given for wet runways or those with reduced braking action.

Aircraft handling and reported wind velocity

Any wind velocity given to an aircraft is a proxy of some sort for what the wind velocity actually is where the aircraft is at that time. The degree to which it is a proxy will always be greater at higher general wind speeds, but will also be dependent upon aerodrome-specific factors. Well recognised and significant local effects should be detailed in the AGA section of the State AIP.



Intelligent use of available wind velocity information can be crucial for avoiding runway excursions caused by loss of control near to, or on the ground. Points to consider include the following:

- The W/V provided as 'instant winds' by ATC should be from the data display for the most appropriate sensor for aircraft position - but a pilot may not necessarily know where that is.
- The 'instant wind' may be exactly that or may be a mean figure automatically generated over a few seconds.
- The display from which an instant wind is taken may be a digital display, with or without an independent display of the short term average, range and trend in wind speed and direction, or it may be a pair of simple mechanical dial displays.
- All 'instant winds' are best interpreted in the context of the amount of short term fluctuation they appear to indicate.
- Any wind direction given by ATC to aircraft about to land or take off should be expressed in degrees magnetic so as to correspond to the similar designation of runway alignment.
- The significance of rapidly changing instantaneous wind velocity for aircraft handling in the absence of any definite trend may be affected by the weight of the aircraft and its consequent inertia in respect of flight control inputs, and in respect of the delayed response to thrust lever movement on large fan jet engines.

Related Articles

- Runway Excursion
- METAR
- Low Level Wind Shear
- Terminal Doppler Weather Radar

Further Reading

- World Meteorological Organisation (WMO) Guide to Meteorological Instruments and Methods of Observation
- ICAO Annex 3 'Meteorological Services for International Air Navigation' Chapter 4 Meteorological Observations and Reports.
- FSF ALAR Briefing Note No 8 - Wind Information www.skybrary.aero/bookshelf/books/870.pdf

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In the next issue of HindSight: Fatigue

EUROCONTROL

Putting Safety First in Air Traffic Management