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

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Front Cover Picture: The image is one of the new S92 SAR Helicopters that is now in use for the Gap SAR contract operated by Bristow Helicopters out of the Sumburgh base in Shetland in the north of Scotland.

With Thanks to Capt. Adrian Bateman – Global Flight Safety Manager

FDM and Training

by Dai Whittingham, Chief Executive UKFSC

I attended an ECAST-sponsored FDM operators' conference last month and was struck by the wide range of cross-connecting issues that were being discussed. The variety of issues was perhaps not surprising given participants who themselves ranged from representing major wide-body airlines, through aircraft manufacturers and data service providers, to small business operators struggling to make sense of FDM when faced with very small numbers of pilots and suitably equipped tails. However, some threads emerged that I thought would be worth exploring further to see if more value can be gained from FDM programmes across the industry.

At the risk of starting with a sweeping generalisation, I believe that EASA Member States have it right when it comes to the importance placed on FDM as one of the best proactive safety tools available to us; I am not sure the same can always be said of matters across the Atlantic. I make the observation not to throw stones, but simply to suggest that this may affect the willingness of some manufacturers to fully embrace FDM, especially for the smaller business platforms where an FDM capability is not mandated. If you are building new aircraft for the business market it would be sensible to include FDM as an option from the outset regardless of size. If you have to generate the data for an FDR, why would you not go the extra mile and make it available to feed an FDM system? This is especially true if your customers are asking for FDM – it is not good enough to dismiss the request on the grounds that it is not mandated and is therefore un-necessary weight and cost. Some pressure from the insurance industry here would be useful in helping to make the economic case – the safety argument has already been won elsewhere.

If more of the lighter business jets and turboprops were FDM-equipped, there would be an enormous opportunity for data-sharing that could at a stroke remove one of the biggest obstacles to effective FDM for small operators, namely small samples and the resultant difficulties with trend analysis. This data-sharing is already happening in the UK in the form of CASE (Corporate Aviation Safety Executive), a gathering of corporate aviation operators that are now pooling de-identified data for mutual benefit. One of the spin-offs from this initiative may be the development of common SOPs between CASE members that could ultimately reduce the training bill for pilots new to the sector. CASE will rely heavily on commonality of data-frames to ensure that analysts can compare like with like. There are clear implications here for the wider industry too. Where is the definition of core values that should be common to all FDM programmes? Granted, there will inevitably be differences between aircraft types, but it should be possible to define some basic principles and events that could be aggregated for analysis. As we get ever safer in the air – and the raw statistics show this to be the case – teasing the trends out of small samples will become increasingly difficult, and we need to take every opportunity to gather and make best use of the available data. At this point, I will also offer another snippet from the ECAST conference, which was the need for mathematically rigorous statistical analysis rather than the more superficial 'top 10 events' approach. Implicit in this is a requirement either to employ a statistician, train your FDM team, or out-source the analysis. FDM data should be feeding your SMS, and you should not be making safety-related decisions on the basis of a poor analysis.

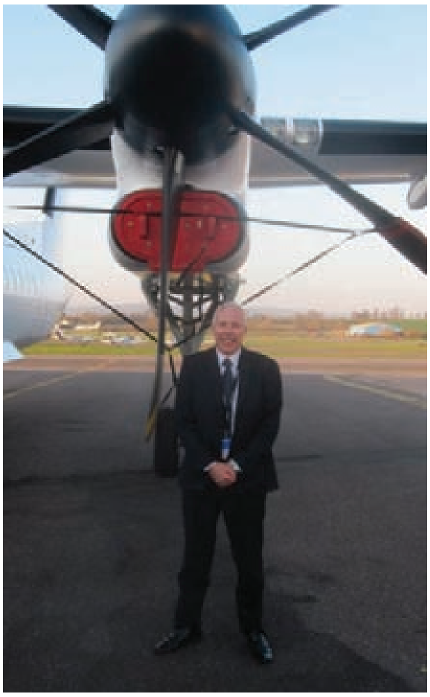
As an adjunct to the argument for extending FDM to lighter types, I believe there is also a case for bringing FDM into the initial training arena. There would be a number of benefits here, not least in making FDM routine business for all pilots regardless of which sector they end up in. The biggest impact would be in the quality of the flight training itself. Post-flight debriefs are crucial but are only as good as the recall and skills of the instructor. If we could now offer the student a real-time visualisation of exactly what he or she did when things started to go wrong (or right...), it would be a very powerful learning mechanism. It might also take some of the subjectivity out of the assessment of individual progress and would certainly allow instructor review of solo exercises. If such a mechanism allowed you to shave a few hours off the training bill, it should rapidly repay the investment.

This brings me to the linkages between FDM, training and flight simulators. The move towards evidence-based training appears to be unstoppable, and rightly so in my view. Evidence from FDM analysis is now routinely fed into initial and recurrent training programmes along with information gleaned from accident and incident investigation. However, the simulator itself is also a rich source of data on crew performance. A high speed RTO is likely to be investigated by a national authority but is an uncommon event. Conversely, hardly a simulator session goes by without one! If we had the facility to run FDM on our simulators we would be able to assess, for example, the average speed of response from detection to action for an RTO and hence gain a better understanding of the real over-run risk; it could also show whether the type airworthiness certification assumptions in this area were (or were still) valid. No doubt there will be issues of confidentiality raised, and there would clearly need to be protocols established for data handling, though these would be less acute where the operator owned the simulator rather than a third-party provider. That said, the volume of de-identified data generated by a simulator in near-constant use should offer some intriguing prospects for analysis.

The problem with the above lies in the technology – the simulators simply aren't equipped for data extraction that could be read easily into an FDM programme and there is currently no requirement of financial imperative for them to be so. However, the fact that the simulator is software driven offers the possibility of translation into a compatible format. If we now reverse the polarity of the question (often a useful technique) a translation capability should also make it possible to use FDM or FDR data to feed the simulator directly, which could be used for remedial training purposes as well as for accident investigation. It might be costly initially, especially to retro-fit existing simulators, but it would be a very useful addition to the certification requirements for a new type. But until there is a requirement, I acknowledge it will not happen. Over to you, Regulators....

Is technology a good thing?

By Capt. Neil Woollacott, flybe



Over recent years technology has been gaining rapid ground, maybe more than we realise and will certainly continue for the foreseeable future. The question is does this technology improve Flight Safety?

Undoubtedly, advances such as Traffic alert/ Collision Avoidance System (TCAS) and Enhanced Ground Proximity Warning Systems (EGPWS) have added immensely to safe passage of aircraft, but are we in danger of losing sight of the basics of how to fly? Air Traffic, Engineering and Ground Handling have benefited hugely from technological advances, and in most cases, made the workload less painful (I didn't say easier!), and safety has improved. But what about the pilots?

When the digital watch was introduced in the 60's, manufacturers, in their attempt to grab the market, used all the technology they could to develop it, adding more and more features that had nothing to do with telling the time! The same can be said of the mobile phone. The days of the 'brick' are long gone and the next generation 'phones do everything short of preparing the evening meal'!

The new generation of pilots have to learn how to operate complex systems at the flick of a finger and most, with their IT skills learnt almost from the cradle, are adept in the use of Flight Management Systems and their ancillary components. Is life in the cockpit of a modern aircraft becoming a serious video game?

In order to prepare these pilots for modern age, training aircraft have to keep up with the times and many are now equipped with 'glass cockpit' instruments, and various other 'state of the art' systems. Of course, the basic flying skills must still be learnt and demonstrated, in order to begin the long road to a commercial licence. But once a pilot begins commercial flying, how much of the basic skills are retained? It is sometimes difficult to see where it is in the system operators continue to maintain their pilot's basic flying skills.

One only has to look at most companies' Standard Operating Procedures to see how soon the autopilot should be engaged after take-off, to when it is disengaged to exit the destination runway. Technology will soon, no doubt, arrange for the aircraft to taxi onto stand and shut itself down. Experienced pilots of today have many thousands of logged hours, but how many of those are actually flying the aircraft? Excellent as modern simulators are, even they cannot replace the 'feel' of genuine flight.

I am not against technology- far from it, but I think that the aviation industry must not, whilst welcoming all of these improvements, lose sight of what we expect our pilots to be able to do when all around is failing- AVIATE!

Have you noticed how modern digital watches now actually tell the time and do very little else?

Statistics in Flight Data Monitoring

by Edward Davies

The Purpose of Statistics in FDM

Statistics are an important part of a Flight Data Monitoring (FDM) system since they give an aerial view of the situation which is lost by only concentrating on specific occurrences, (known as Events). Statistics are important at board level to assess how matters are improving or deteriorating over time, with reports such as "Top 10 Events per Month", however more detailed lower level statistics can be used in abundance by Flight Safety Officers (FSOs) to drill down into the data and find the specific areas for improvement.

Statistical representations of data allow us to visualise at a glance the most important features and trends in a set of data, and well designed statistic reports communicate the data in a clear manner.

The Hazards of Summary Statistics

Statistics can be misleading to the unwary and must be treated carefully. As an example, suppose we are comparing the event rates of two airfields:

- At Airfield A, 49 approaches out of 50 have triggered an FDM event. This gives an event rate of 980 events per 1000 flights.
- At Airfield B, one approach was made and one FDM event triggered. This gives an event rate of 1000 events per 1000 flights.

Just comparing the event rates, "statistically" Airfield B has a more severe record of events than Airfield A. However, when taking into account the number of approaches, most people would agree that the figures for Airfield A are more concerning. Since only one approach has been made into Airfield B, the pilots may be unfamiliar with the airfield and thus may be more susceptible to making an error. In contrast, with 50 approaches into Airfield B and events still occurring on most approaches, this would be a cause for concern since the problems with the approach are clearly persisting.

As a second example of how a first glance at a statistics report can be misleading, suppose we want to compare events over a 6 month period:

- Event X is the most frequently occurring event with 100 instances.
- Event Y is the second most frequent event with 80 occurrences.

With no further information we may conclude that Event X is the most pervasive problem in the operation. When drilling down by splitting these figures by airfield however, we find that 95 of the instances of Event X occurred during the approach to a specific airfield, and only 5 occurred elsewhere, whereas the 80 occurrences of Event Y were spread evenly over many different airfields. With this further information we find that Event Y is a more pervasive problem, and Event X is mainly local to a specific airfield.

These examples demonstrate the need for Flight Safety Officers to be able to bridge the gap that separates the top level overview statistics and the precise details, rather than just being limited to viewing one extreme or the other. This leads on to the next topic: Interactive Statistics.

Interactive Statistic Dashboards

The Business Intelligence (BI) software available today enables the use of Interactive Statistics, (also called Dashboards), for the benefit of flight data analysis. Interactive Statistics differ from traditional fixed reports in that the user can change parameters using a variety of typical user interface features such as selection boxes, drop down lists, and range sliders. Some examples of this in the context of FDM reports are:

- Varying the date range from and to specified months or dates.
- Opting to view specific fleets or aircraft tails.
- Viewing the statistics for a specific event.
- Filtering the data to just show events for particular phases of flight, such as "Takeoff and Initial Climb" or "Approach and Landing".
- Focussing on specific airfields, countries or regions.

In effect, the ability to adjust many parameters in an interactive report changes the view of the data from one fixed report to having thousands of different possible reports at your disposal. With the additional facility to bookmark sets of filters, the reports that need to be accessed regularly can be easily loaded with a few mouse clicks.

(FIGURE 1) shows an example of an interactive report; the parameters that can be adjusted are Date, Event Category (such as "Speed", "Configuration", and "Engines"), Event Section (such as "Takeoff and Initial Climb" or "Approach and Landing"), Event Name, Fleet, Aircraft Tail, and Level (Severity). In this example, when hovering the cursor over a bar, the trend line of the number of events per month appears; this is a useful drill down view and gives more information than the bar gives on its own.

There are endless possibilities of how Interactive Statistics can be used in Flight Data Monitoring, and with the software available today there is room for much ingenuity and creativity.

Interactive Statistics Report

Figure 1 – Interactive Statistics Report:
Source: Flight Data Services

Histograms

Events are traditionally the main building blocks of an FDM system, and these specific cases of parameter exceedances - often corresponding to Standard Operating Procedure (SOP) limits - are the main source of information for the Flight Safety Officer. There is however another type of measure that can be extracted from the data to allow trending, and these are called Snapshots or Key Point Values (KPVs).

KPVs are values taken for particular parameters at specific points in every flight. A few examples are “Airspeed at Gear Up Selection”, “Flare Distance 20 ft to Touchdown”, and “Rate of Descent Below 10,000 ft Max”. The Key Point Values are computed from algorithms when the flight data is processed, and when enough flights have been processed you can start to build a picture of the data using a histogram.

A histogram is a graphical representation that displays a collection of data by splitting it up into intervals of equal length known as bins, and then plotting a bar of height equal to the number, (or frequency), of items within that bin. In the case of the KPV “Flare Distance 20 ft to Touchdown”, the bins may be “0 to 1 second”, “1 to 2 seconds”, etc, so if the flare duration was 6.5 seconds it would fall within the “6 to 7 seconds” bin.

The shape of a histogram is also called its distribution. Given enough flights, a distribution will become smoother and will show the approximate nature of the underlying data; a statistician is then able to identify a probability distribution that this corresponds to such as the Normal Distribution or Poisson Distribution. Generally speaking, the Normal Distribution often applies to a measure taken from every item within a population so may apply to a KPV, whereas the Poisson Distribution applies to rare events so could be applicable to FDM events. Further details on statistical distributions is outside of the scope of this article, but please see the bibliography for further reading of distributions in the context of flight safety.

Collaborative Comparison

One of the main frontiers of FDM is collaborative comparison of statistics across operators. If multiple operators are collaborating by sharing their data, histograms such as the example above can be built with a much larger pool of data, and from a statistician’s point of view, more data is better. The operator will then be able to view their histogram and the average histogram for all other operators on the same axes to see how they compare. Operators can also agree to compare their data directly with one another so that they can see objectively if they have some catching up to do in terms of the quality and consistency of their operation compared to their contemporaries.

(FIGURE 2 overleaf) is a histogram for “Flare Distance 20 ft to Landing”, and illustrates collaborative comparison of statistics. The grey bars represent the number of flights in each bin for a specific airline, (let us call them Airline A). The black line superimposed on top of the bars is called a frequency polygon, and this represents the data in the same way as the bars but is useful in visualising the shape of the histogram. The blue dotted line is the frequency polygon for a collection of other operators of the same aircraft type for comparison, and we can see clearly that the flare durations for the operator are longer than the average. At the upper end of the distribution, regions are shown in green, amber, and red for increasing event severity levels which correspond to the Long Flare event, and any flights within these regions will trigger an event. It is clear from the diagram that the area below the curve within the event regions is a

Flare Duration Histogram

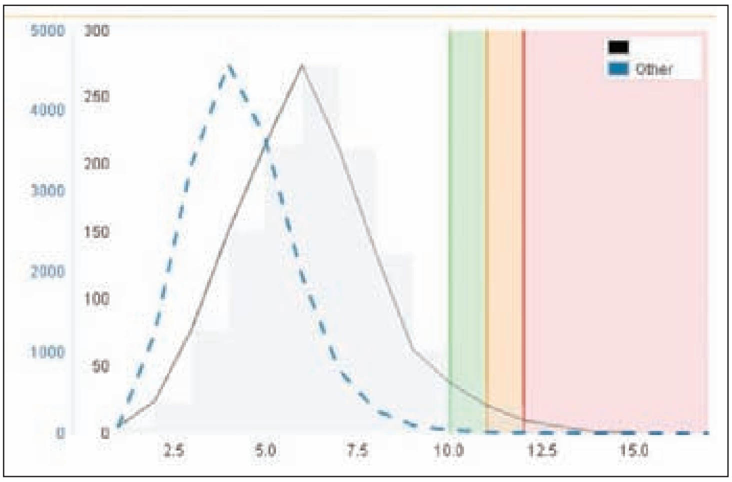


Figure 2 – Flare Duration Histogram:
Source: Flight Data Services

lot greater for Airline A than the average among other operators, and this will be a clear visual indication to Airline A that there is room for improvement.

Comparative statistics require a common platform for the flight data to be analysed, and Open Source software projects allow for this possibility without requiring all operators to be using the same FDM software or service provider. Please see the bibliography for more details on Open Source projects.

Conclusion

Since first being introduced to Flight Data Monitoring, I have believed that the wealth of available recorded data on the aircraft – particularly in newer aircraft – has a myriad of possible uses, and that there must be many ways this data can be used for the benefit of flight safety. The regular routine downloading of data from all aircraft within a fleet and analysing that data for events is a massive step forward from the traditional approach of the past of only analysing the data after a crash, and it is reassuring as a member of the public that FDM is mandated within Europe. None the less, the flight safety industry is generally still only using the tip of the iceberg with respect to the amount of information available. To put into perspective the amount of data recorded we only have to look at the Dataframes of aircraft. The Dataframe is the arrangement of parameters that the Flight Data Acquisition Unit (FDAU) sends to the Flight Data Recorder (FDR) and Quick Access Recorder (QAR). In the past, Dataframes only consisted of a handful of mandatory parameters such as pressure altitude, airspeed, and vertical acceleration, but today with the practically unlimited capacity of computer memory, it is normal for Dataframes to consist of a thousand parameters or more. Naturally not all of these parameters are useful for FDM, but it is very likely that this data can be used in ways to benefit flight safety that no one has even thought of yet.

I believe that concepts such as Interactive Statistics, Key Point Values, and collaborative sharing of flight data allow flight safety to move forward to the next level. Finding ways to maximise the proactive use of this huge abundance of data at our disposal is the task of the latest generation of flight safety professionals, and with the software widely available today, there is no excuse to be content only with traditional approaches.

Bibliography

For further reading on statistical distributions in flight safety: "Systematic Safety: Safety Assessment of Aircraft Systems" by E. Lloyd and W. Tye, Civil Aviation Authority, ISBN-13: 978-0860391418.

A recommended text on statistics: "Probability and Statistics" by Morris H. DeGroot and Mark J. Schervish, Pearson, ISBN-13 978-0321709707.

For more information on Open Source Flight Data projects, please see: www.flightdatacommunity.com

About the Author

Edward Davies is an Associate Member of the Royal Aeronautical Society and a Fellow of the Royal Statistical Society, and has an honours degree in Mathematics. Edward has four years experience as a Flight Data Analyst and Statistician at Flight Data Services Ltd.

Training for Volcanic Ash Encounters

by Holly Aird

Many major air traffic routes cross heavily volcanic regions, and although volcanic ash is only expected to be at cruising altitude for approximately 20 days of the year, the effects of an encounter are costly and potentially life threatening.

The eruption of the Eyjafjallajökull (AY-uh-fyat-luh-YOE-kuutl-ul) volcano in April 2010 caused immense disruption to air travel and operations across Europe and dramatically brought to the public's attention the risks of flying through volcanic ash. The aviation industry were prepared for such an eruption, and through data provided by the Volcanic Ash Advisory Centres (VAACs) and simulated scenarios from the UK and Icelandic Met Offices action was taken immediately to prevent any inadvertent encounters with the volcanic ash produced.

The efficiency of volcanic ash monitoring today has led to a drop in the number of reported aircraft encounters with volcanic ash since 1991, which has been simultaneous with a vast expansion in air traffic over volcanically active regions, and eruptive activity remaining roughly constant. However, a concern produced from such effective mitigation of volcanic ash encounters is that it can create flawed assumptions within the airline industry that the threat of this hazard has been all but eradicated, leading to potential issues of complacency. Volcanic ash incidents can still occur for a variety of reasons, ranging from a simple breakdown in communication between facilities to the time restrictions and difficulties of processing satellite data. It is therefore imperative that pilots remain aware of this hazard and are conscious of the fact that there may not always be a warning of such an encounter, as a pilot of an aircraft is the last link in the chain of safety actions to avoid or mitigate encounters with volcanic ash.

Prior to this notorious eruption, research was conducted to establish what pilot opinions on volcanic ash encounters with commercial aircraft were in order to identify and understand attitudes towards this hazard. Data was collected through questionnaires distributed on the BALPA website in the members forum between September and December 2009 and was supported by interviews conducted with Eric Moody, Captain of the first known aircraft encounter with volcanic ash, and a Training Captain of a UK based airline.

Handling volcanic ash encounters

The main aim of the study was to understand how a pilot would feel about experiencing an aircraft encounter with volcanic ash. Although there were varying attitudes as to how respondents said they would feel most answers showed a very practical approach, ranging from those who would be confident as they know what to do, to those who would consult the books on the flight deck. Even those who did not actively state they would feel 'confident' in enacting volcanic ash procedures knew how to solve this problem and keep the flight under control. This practical approach was found to be part of the mentality of a pilot, as due to the nature of their job they should be calm and collected under pressure, ensure they have all the facts to hand and have flight safety as their number one concern.

However, what was also found through studying the pilot responses was the potential issue of complacency. Several responses suggested that the pilot thought they would never be in a position where they would experience volcanic ash because there would be always be a warning of an encounter; others stated that they expected to be rerouted around the ash cloud, and so were confident about avoiding the ash. Although they vary in scale and intensity, almost all volcanic eruptions are capable of pumping ash to heights in the atmosphere where aircraft could encounter them. Encounters between commercial aircraft and volcanic ash do still occur; based on previous volcanic activity it is predicted that volcanic ash can be expected at altitudes over 30,000 feet on major air traffic routes for approximately 20 days per year worldwide. It is possible therefore, depending on the flight path and proximity to the volcanic eruption, that there would not always be such a timely response to an imminent volcanic ash encounter. Even if an eruption is known about there can still be time delays in sending appropriate information to pilots, such as a breakdown of communication between agencies or an extended period of satellite image processing. As of 2010 there were 94 known aircraft encounters with volcanic ash, out of which 79 resulted in either engine or exterior surface damage.

This issue of complacency was also highlighted through the Training Captain interview. His concern was that because (at the time the research was conducted) an ash encounter had not occurred for so long, pilots were more likely to believe that they would never experience it as these types of encounters are so rare, and because there are effective warning systems in place. The Training Captain also pointed out that this is precisely why pilots are re-trained for their aircraft type every six months, alternating between a standard check of normal operating procedures and line orientated evaluation. The re-training therefore serves as a reminder of the threat posed by volcanic ash, and so acts to minimise the risk of complacency on this issue.

The majority of the respondents believed that there were enough encounters with volcanic ash per year to view it as a real 'threat' to aviation, even though this study was conducted before the Eyjafjallajökull eruption. This was a positive result, as it showed that most of the pilots were aware of the large risks involved in such an uncommon hazard. However, the fact that 38% of the respondents did not think ash should be seen as a major 'threat' to aircraft produced concern, as it is precisely this sort of incident that a pilot would not expect to come across, but would have to take swift action to deal with it if it were to occur. This finding tied in to the earlier concerns of complacency amongst some pilots, again reflecting the perceived attitude of thinking that an encounter would not happen to them.

As present radar instruments onboard aircraft are unable to detect ash clouds, particular observations made by flight crews are the last chance in some instances to prevent an imminent encounter. At night, St Elmo's Fire can be seen on the windshield which can also create a bright, white glow in the engine inlets. Volcanic clouds also cause the aircrafts' landing lights to cast sharp, distinct shadows at night, unlike the fuzzy shadows that weather clouds create. A 'haze' produced from volcanic dust can be seen, generally accompanied by an acrid odour similar to electrical smoke or sulphur, which leaves dust deposits on internal surfaces. The aircraft engines can suffer multiple malfunctions, such as surging, exhaust-gas temperatures rising or flaming out. Airspeed readings can become unreliable (appearing to decrease when no change has occurred) or fail completely if the pitot tubes become blocked with volcanic ash. It is also possible for problems to occur with cabin pressurisation, with the cabin altitude increasing or suffering a loss of cabin pressure.

The pilots who responded were very aware of these indicators that would present themselves should a volcanic ash encounter occur. Most pilots could name three or more, with the most commonly selected indicators being St Elmo's Fire, the acrid odour and engine malfunctions- the most obvious clues to an encounter. This showed a good pilot awareness of volcanic ash and so suggested that an inadvertent encounter would be easily identified by a pilot, and so avoided as soon as this diagnosis was made. However, only 25% of the pilots were able to state that a decrease in the indicated airspeed was a sign of volcanic ash. This was slightly concerning, as a faulty airspeed reading might not be immediately obvious but is a problem that the pilot has to act on straight away and needs to be controlled manually. However, as options were not provided for this question it was inferred that airspeed problems were simply not one of the first indicators the pilots thought of, which also explained the high number of respondents who chose the more obvious features of an encounter. Nevertheless, to have found that a lot of pilots did not immediately think of the airspeed indicators suggested that something needed to be done in order to raise the profile of faulty airspeed readings as a sign of volcanic ash.

The most immediate indicators (St Elmo's Fire and the acrid smell) were chosen as the two 'key' indicators that would confirm to a pilot that they are flying through volcanic ash. This was an encouraging result, as this would mean that pilot action to exit the ash cloud would happen sooner rather than later, and so the engines could be saved from being damaged by ash build-up. These findings also lauded the pilots' attitude, as the fact that they would only have needed two indictors to confirm to them that they were experiencing volcanic ash demonstrated a strong 'better safe than sorry' approach. Therefore, it seemed likely that most pilots would change the route of their flight on the off-chance that volcanic ash was present, thus in certain situations saving the aircraft.

From the responses to this section of the study, it was clear that the pilots questioned had a sound knowledge of the indicators of volcanic ash and would be confident that they were experiencing a volcanic ash encounter should one occur. Several different strategies emerged as to how pilots would have tackled an ash encounter that would have affected their flight, but none suggested that they would not know what to do or would not be able to cope with what was happening. The main tactic that emerged was simple and clear: keep flying the aircraft.

Opinions on scientific progress

The opinions of the pilots studied on the system in place to monitor volcanic ash were generally positive, with just over half thinking that it worked well. Many responses suggested that they would assume there would always be adequate notice of an eruption and they would have plenty of information to hand in fight, which implied these pilots perceived the system to be quick and provide sufficient information to them. Pilots should have faith in the monitoring of volcanic ash, so to have found that over a quarter of respondents thought it could be improved showed that the pilots were aware of the risks posed by volcanic ash and thought that the detection methods were not as good as they could be.

It can be difficult to detect volcanic ash clouds using satellites as they are visually very similar to water and ice clouds. However suspended ash does have a particular signature when using certain forms of satellite imaging, as it has a strong absorption at a particular wavelength, which can be exploited to help distinguish ash from non-volcanic clouds. There are problems with existing techniques in monitoring volcanic ash however, such as missing certain eruptions due to the presence of large quantities of water vapour, (e.g. in tropical environments). Other techniques suffer from problems caused by the satellite used, such as poor spatial resolution or awkward viewing geometry of the satellite nearest the volcano. Currently, there is not one single method of detecting volcanic ash or an individual satellite sensor able to identify volcanic ash in all possible physical circumstances.

It was encouraging to find that a quarter of respondents wanted to be kept up to date with improvements in the detection of volcanic ash, and 65% of respondents wanted to be alerted if there had been a significant breakthrough in these developments. The study judged that it was important to keep pilots informed of the developments in monitoring ash so that pilots would feel that the problems they could face from a volcanic ash encounter were seen as important, and that they were not being left with an imperfect system. The pilots studied did want to know what developments were being made in the detection of volcanic ash, and were highly supportive of the efforts being made to improve the current system.

As might be expected, pilots who flew the most frequently on volcanically hazardous routes were the most concerned about the current ash warning system in place. Those that stated they flew on volcanically hazardous routes at least once a month were more likely to think that improvements needed to be made to the ash detection system, and that not enough was being done by the scientific community to improve these detection methods. This was in contrast to those who asserted they flew on volcanically hazardous routes once to several times a year, who were more likely to think that the system of ash monitoring worked well and were split equally in opinion as to whether enough was being done to improve detection methods.

Pilot opinion and age

Although not part of the original aims of the study, the responses from the questionnaires were also examined to see whether the age of the pilot had any influence on the opinions and answers given in relation to volcanic ash. Through this comparison, it was found that the older pilots were more likely to view volcanic ash as a real threat to aviation, even though there are not many encounters per year. This was judged to be as a result of the oldest pilots in the survey being able to associate the hazard of volcanic ash to a real life encounter. With 36.2 years average flying experience, all of the oldest pilots were likely to have been flying when Eric Moody had the first experience of encountering volcanic ash in June 1982, nearly 31 years ago. This would mean that the pilots who were 51 to 60 were more aware of the dangers that volcanic ash can pose as they have an experience they can associate the hazard to, and so know the hidden dangers and the potential outcome of such an encounter. This would be in contrast to the youngest pilots who will have learnt about volcanic ash procedures from the start of their careers and would not have that real life experience to relate it to, and thus perhaps more likely to assume that the network of VAACs and volcano monitoring would prevent an ash encounter from happening.

This theory was reflected in the responses when questioned about which natural hazards were perceived to be the most risk to a commercial aircraft. The 31-40 year olds ranked 'birdstrike' as the biggest threat to aircraft, whilst the older two age groups (41-50 year olds and 51-60 year olds) both ranked 'microburst' as the biggest threat, with the 41-50 year olds placing 'birdstrike' in second and the 51-60 year olds in second last. The Hudson River plane ditching incident occurred in January 2009, nine months before the survey was conducted, and was found to have been caused by a birdstrike with a flock of Canadian geese. It was deemed possible that this incident acted as a similar 'association event' for the youngest pilots as the older pilots had to Moody's encounter. The younger pilots had therefore now become more aware of the more serious effects of a major birdstrike, and come to realise the real threat posed by an incident that they have been trained for since they qualified as pilots. Although the most recent major aviation incident at the time the survey was conducted was Air France flight AF447, which crashed into the Atlantic on 1st June 2009, the cause of this accident was still unknown at this point, and so would not have had an impact on pilot opinion.

Conclusion

The study concluded that ultimately pilots would feel confident about handling a volcanic ash encounter. Although the pilots studied were able to strategise about how to tackle an encounter, list the indicators that show the presence of volcanic ash, and have faith in the monitoring system in place, several problems were flagged up by this study. It was felt that it was important for the potential complacency issues to be addressed by employing airlines by continuing to re-train pilots, and ensure volcanic ash was still regarded as a major threat to aviation. Improvements towards developing the satellite detection of ash and the information response system should also be highly encouraged and supported by airlines themselves in order to minimise the risks of continuing to fly over volcanically active regions. Further research is recommended in this field in order to verify the results found, especially now the disruption caused by Eyjafjallajökull has reminded the airline industry that volcanic ash remains one of the most costly natural hazards today.

The Human Factor

A new initiative looks at the area of human factors. Barbara Schaffner, Inspector Ground Facilities at the Federal Office of Aviation in Switzerland, is our guide.

So is this yet another requirement for the ground services industry? No- this time an initiative has been launched to support the ground service industry and comply with existing and forthcoming requirements developed by the Ground Safety Working Group (GSWG) of ECAST

ECAST is the fixed-wing Commercial Air Transport component of the European Strategic Safety Initiative (ESSI). ECAST comprises various teams, including the GSWG. The GSWG is co-chaired by IATA, CAA-NL and FOCA-CH.

Although it has previously published other training recommendations (see box below), ECAST has now come up with a way to improve safety on the ground without further burdening the ground service industry with yet another requirement to fulfill (and with little guidance on how to be compliant). ECAST has searched for a way to improve on what is already descending upon the ground service industry Human Factors Training.

A syllabus for RRM (Ramp Resource Management) training has therefore been developed and published on the ECAST Web page (again, see box below). The project was led by the NLR for CAA-NL and ECAST. The RRM syllabus and guidance material is an easy, comprehensive package that will support ground service providers and aerodromes in complying with the requirements to train staff in Human Factors. RRM extends the CRM principles to the ground handling environment and these principles provide the contents for the RRM training syllabus. Whereas CRM training mostly addresses teams of two or three members, RRM training also addresses larger teams, and is similar to Team Resource Management (TRM) training that is provided to air traffic controllers in the air traffic management domain. The target group for RRM training is ramp personnel, including permanent and temporary employees, supervisors and team leaders.

Since the initiation of ECAST and the GSWG, many industry initiatives have been introduced. These include IATA's ISAGO programme, the IATA IGOM and the CAA UK'S GHOST who, for example, produced the impressive DVD entitled Safety in the Balance. ECAST supports all these initiatives and encourages the introduction of common standards. Standardisation of ground operations in accordance with Best Industry practices can be considered to have a positive impact on safety.

The reasons for the syllabus

So why develop a Human Factors syllabus especially tailored for the ground service industry? There are new and already well-known challenges imposed by airlines, aerodromes, audit programmes, certification programmes and, to a varying degree, authorities. However, there is little guidance on how to comply with many of the requirements. Many of the requirements the ground service industry has to comply with are based on the international regulations addressing aircraft operators and aerodromes, with the NAA, aircraft operator and aerodrome having a varying degree of responsibility over the ground service industry's area of work. In addition, there are local regulations such as Health and Safety Regulations and industrial agreements that a ground service provider has to consider. Not always do the laws and these requirements go hand-in-hand.

ECAST fully shares the ICAO/EASA position that good Human Factors practice benefits aviation safety, both in the air and on the ground. There are many studies with regard to Human Factors training for flight operations and the technical areas (such as maintenance and engineering). Guidance and best practices addressing CRM training for flight and cabin crews have been researched and published. But there has hitherto been no published material tailored to training in Human Factors for the ground services industry. Based on standards published in the aircraft operators' ground handling manuals and because of ISAGO requirements, the request to train staff in Human Factors is coming more and more into the spotlight. But the ground service provider has, so far at least, not been given any guidance material on which to base such training. This is what ECAST has changed and for anybody who is interested, information can be obtained on the ECAST Ground Safety Web page.

ECAST has not only provided the syllabus but also the recommendations for the conduct of these training sessions, as well as guidance on instructor qualifications. A comprehensive package has been developed for aerodromes and ground service providers to create their own Ramp Resource Management Training. The package also includes two Human Factors and Safety Culture studies in ground service operations which have been developed by the NLR for the CAA-NL and ECAST.

ECAST recommends that the classroom training be held by the aerodromes to support a non-homogeneous group. Ideally, participants will be drawn from various ground service providers to enhance the awareness and co-operation between different companies operating on the same aerodrome. The various interfaces are one of the major challenges ground service providers have to manage.

Therefore this aspect is highlighted in the preamble of the RRM package. Furthermore, the training itself can be adapted and adjusted to any ground service provider or aerodrome. For further information please see the complete package on the ECAST Ground Safety Web page.

The European Commercial Aviation Safety Team (ECAST) is the fixed-wing Commercial Air Transport team of the European Strategic Safety Initiative (ESSI). ECAST is co-chaired by the European Aviation Safety Agency (EASA) and International Air Transport Association (IATA). ECAST has established a Ground Safety Working Group.

Deliverables from the Ground Safety WG team include:

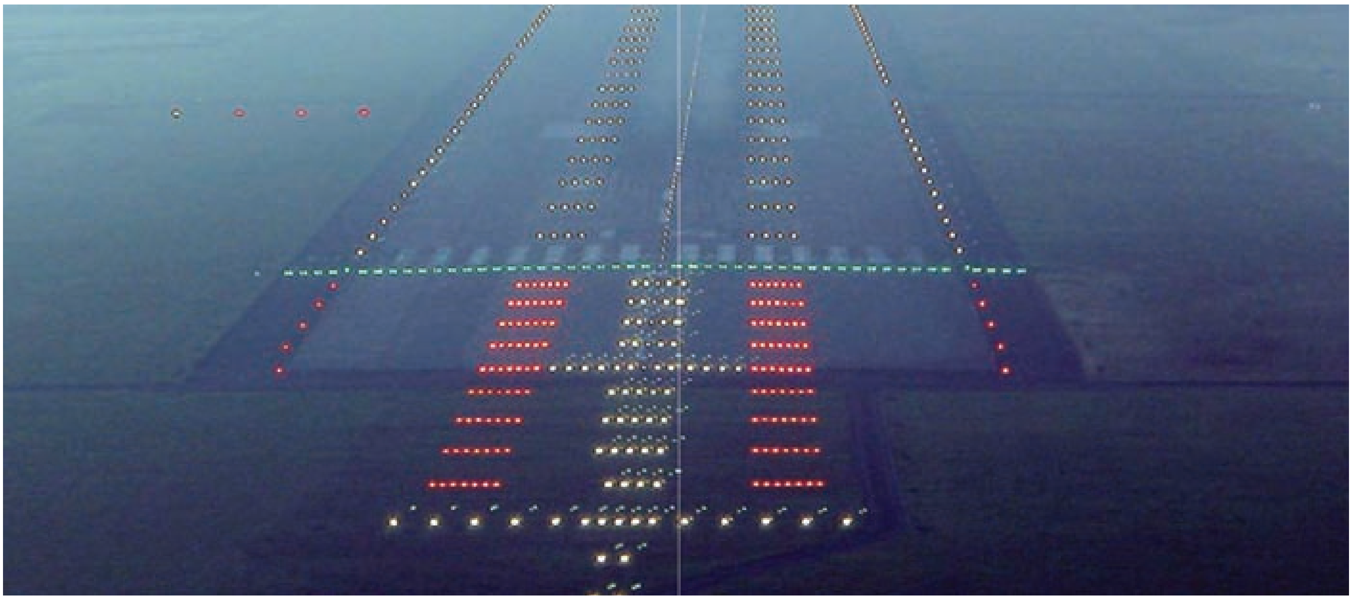
1) Ramp Resource Management training syllabus and course material
2) Just culture and human factors training in ground service providers
3) Training recommendation for ground handling staff
4) Support of safety initiatives such as IATA, IGOM, IATA ISAGO and the IATA Ground Damage Database project; and GHOST by the CAA UK

The deliverables are available on:
http://easa.europa.eu/essi/ecast Ground Safety

By ECAST supported initiatives in Ground Safety
http://www.caa.co.uk GHOST- DVD Safety in the balance
www.iata.org ISAGO, IGOM

The Drive to Arrive
Why Professional Pilots Get Press-on-itis

by Imogen Cullen – Safety Specialist



"Failure to recognize the need for and to execute a go around is a major contributor to runway excursion accidents".

– states the Flight Safety Foundation Runway Safety Initiative Report. Not going around was found to be the single largest risk factor in all runway excursion accidents between 1995 and 2008, occurring in 34% of runway excursion accidents, followed by landing long (see figure 1). No small problem then.

A simple rule of thumb in the study of human error is that experts tend to make skill-based errors - simple slips and lapses like forgetting to select flaps, twiddling the wrong knob, or 'checking' the programmed approach in the FMC but not really taking in what it says. These errors are made by expert operators because human cognition has evolved to use swift and automatic, rather than slow and conscious, cognitive processes to manage familiar tasks in the most efficient way it can. Knowledge based, or decision making errors are more commonly associated with novice operators, using highly conscious effort. Experts are apparently less likely to make decision or problem solving errors because they have experience and knowledge in their long-term memory to draw on. Yet, one decision error that continues to be made by experts is failing to go around.

Burbank, 2000

An oft-cited accident example of failing to go around when necessary is the B737-800 accident at Burbank, California in 2000. The B737-800 ran off the end of runway 08 (1768m) at 32 knots and stopped by a gas station outside the airport perimeter fence. The captain believed he could make the visual approach, which was commenced "hot and high" with a tailwind after air traffic control had positioned the aircraft close in. The tailwind on finals meant that, under company procedures, the crew were required to fly the approach at Vref + 5 knots. Vref was 138 knots and the aircraft touched down at 183 knots. Throughout the approach, the first officer had noticed the excessive speed and approach angle, but did not make the standard call outs because he could see that the captain, in progressively selecting gear and flap (albeit in excess of the limiting speeds in some cases), was doing something about it. Despite these efforts, the GPWS alerts, "sink rate" and "whoop, whoop, pull up", sounded throughout the approach. The captain knew the aircraft was not "in the slot" at the prescribed gate, but says he did not realise the extent of the deviations. In fact, the aircraft was descending on a seven degree slope in excess of 50 knots over Vref on short finals. The NTSB concluded that the crew should have conducted a go around in accordance with their company procedures when the aircraft passed the stable approach gates without having stabilised the aircraft speed and profile.

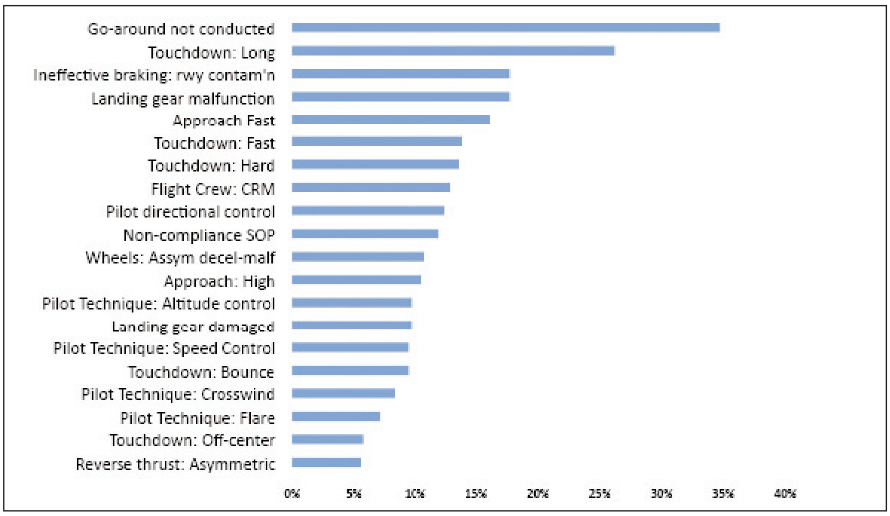


Fig. 1 Landing Excursion Top Risk Factors (FSF)

Bangkok, 1999

On a stormy night in 1999, a B747-400 overran runway 21L (3500m) at Bangkok's Don Muang Airport at a speed of 88 knots. The aircraft landed long in heavy rain, with thunderstorms in the vicinity, and aquaplaned on the water contaminated runway. The crew had received a 'good' braking action report from a preceding aircraft and did not experience any adverse weather on the approach until entering the heavy rain at approximately 200 feet on the ILS. The aircraft was configured for a Flaps 25 landing and idle reverse was planned by the crew in accordance with company procedures. While the aircraft was within company deviation limits when it crossed the threshold, it was nonetheless a little high and fast, at 76 feet above ground and 15 knots over Vref. It overflew the touchdown zone by 600 m before touching down and aquaplaning. The captain called a go around, but when the main wheels touched, he cancelled that decision without announcing it to the rest of the crew and in the confusion, reverse thrust was not selected. The ATSB concluded that the crew had not planned for a contaminated runway and adjusted the standard aircraft configuration accordingly, that the pilot flying (PF) did not accurately fly the approach and that despite being within company speed limits, the speed crossing the threshold was excessive for a contaminated runway. They also found that the captain should not have reversed the go around decision.

Common ingredients in these, and other runway excursion accidents, include unstabilised approaches and bad weather. However, numerous other conditions may necessitate a go around. For example, if any doubt exists about the position of the aircraft or the integrity of navigational guidance (from either the aircraft or the airport aids) a go around is required. Additionally, aircraft performance problems, non-normal indications, as well as instability late in the landing like excess speed or height over the threshold, extended flare, off centre-line and over-controlling, can also necessitate an unplanned go around.

Stable approach criteria are clearly outlined by most airlines and generally well understood by pilots as mandatory operating limitations, not targets or advisory guidelines. So it's not usually a misinterpretation of SOPs that results in pilots deviating from stable criteria. Nor is it likely that crews have intentionally violated these clear cut boundaries; accident investigations frequently find that the pilots were known as conscientious by their peers and trainers. What's more, it is frequently highly experienced pilots that, despite their better judgement and training, end up in these situations. The Bangkok accident captain was an experienced check captain. Our own recent FOQA program reports have highlighted several worrying trends that indicate we are not immune to the global runway excursion risk, such as high descent rates, late flap or gear selections and deep landings (extended flare).

21 people died when this B737-400 overran the runway at Yogyakarta after a high speed approach in 2007

So, why do good pilots make bad decisions and persevere with landings that should be given away? Why, knowing that the weather is bad, that runways are wet, or short, or both, would normally conscientious pilots elect to continue approaches that are hot and high when so many aircraft before them have met disastrous ends in similar scenarios?

Why good pilots (and other people too) make bad decisions

Given that most of us do what we think is reasonable at the time based on available information and do not consciously drift into risky behaviours, it is worthwhile attempting to understand natural human tendencies that can make even expert pilots vulnerable to decision errors during the approach and landing.

One commonly identified cognitive phenomenon that can make it difficult for pilots to recognise the need to abandon a landing attempt is plan continuation bias (PCB). This is a tendency, that you will have been hearing more about recently in our own internal training program, to continue a plan of action, when "the situation diverges from the premises on which the plan was originally built" (Dismukes et al, 2007). As humans, we are prone to a number of decision short-cuts, or heuristics, to make our jobs easier by reducing the workload incurred by complex information processing and decision making tasks. PCB is one of these and one common manifestation is failing to recognise the need to abandon an approach and landing attempt. PCB can arise from several converging phenomena.

Social influences

Firstly, social and organisational influences can subtly affect pilot decision making. Generally, people are subconsciously reluctant to abandon a plan in which they have invested heavily and accept the inevitable losses. According to "prospect theory", perceived losses have greater influence over decision making than an equivalent gain. For example, in aviation, on-time performance pressure and compounding delays caused by late arrivals, create a strong get-there drive for pilots, which can influence them to continue an approach. While getting to your destination is expected, diversions are highly inconvenient and expensive. Given that pilots tend to be goal-driven and performance motivated, the disadvantages associated with going around can be perceived as a lesser evil than continuing an untidy approach. Additionally, a decision to divert in changeable conditions may be perceived by crews as difficult to justify when other aircraft are getting in. For some pilots, going around may also be considered a loss of face, an acknowledgment that they have messed up the approach.

Under-estimation of risks

PCB in relation to failures to go around may also be influenced by overconfidence, or perhaps more correctly, underestimation of the risks associated with continuing. Pilots can get accustomed or desensitised to weather threats and slightly unstable approaches which, most of the time, do not result in unsafe consequences. They pride themselves on being able to deal with situations that arise in flight. It's part of the job right? In some cases, inappropriate or difficult ATC clearances, such as high speed or close-in approaches, can sow the seeds for a PCB mind state; this was undoubtedly a factor in the Burbank accident. Pilots may accept such ATC instructions due to professional pride in being able to make it work or professional courtesy to ATC or other aircraft, without consciously addressing the associated threats. Thus, pilots' performance-motivated drive can result in a mindset of "I can fix this" and the consequent task fixation can increase the odds of pilots persevering through the stable approach gates in the belief that flight parameters outside of prescribed limits will shortly be back within tolerances. Yet, every time we get away with it, we are reinforcing that behaviour to drift over that invisible line and we are increasing our risk for next time. Not surprisingly, experienced pilots may be more at risk.

Effects of high workload and stress – attentional narrowing and missed cues

However, despite our best intentions and self-confidence that, as professional pilots, we continually re-evaluate available information and respond accordingly during all flight phases, sometimes our level of situational awareness is far less than we assume, making a change of plan even more difficult. In many cases, PCB can be linked to high workload and stress. "Attentional narrowing", or tunnel vision, can prevent us from detecting available cues as workload and stress increase, because our visual and cognitive attentional focus tends to narrow, and peripheral information is easily missed. In challenging approach and landing conditions, those effects can exacerbate inherent difficulties in recognising a need to change plan, perpetuating PCB. Moreover, high cognitive workload can result in insufficient available cognitive resource, or thinking power, to properly process even the information that is noticed. Consequently, alternative hypotheses that contradict existing perceptions of both aircraft and environmental state may not be properly addressed. Fatigue undoubtedly exacerbates those effects. The crews of the Burbank and the Bangkok accidents described earlier were both found to have been affected by a high, even snowballing, workload during their respective approaches. By attempting the visual approach with the aircraft energy as it was, the Burbank crew set themselves up for a high workload approach, in which obtaining a standard profile and speed was almost impossible, and in which maintaining full cognitive capacity was always going to be challenging. Not surprisingly, the captain became fixated on capturing the approach profile. In the end, both accident crews lost awareness of their actual aircraft states as they flew through their respective stable approach gates without the required conditions. Despite cues that are obvious to anyone looking back on the incidents, neither crew addressed the need to go around.

Another effect of stress is that people become increasingly biased towards familiar, well-worn paths. Under high workload, the prospect of attempting a go around, itself a demanding cognitive task that is at risk of mismanagement, and possibly a diversion to another airfield, is highly unpalatable. It is not hard to see how persevering with an untidy ILS and getting the aircraft on the ground is a strong and seductive influence on decision making. This is especially true if the runway is in sight, as it provides a compelling target. To put it simply, we are programmed to subconsciously take the path of least (perceived) effort; particularly under high workload. Even if the risks of doing so may be higher, we are less likely to properly attend to those disconfirming cues, and more likely to anchor ourselves to those that support our drive to continue.

Lack of prominent cues

Tendencies for PCB are not aided by the fact that the available cues that could jolt a pilot out of pressing on are themselves often ambiguous and lacking in attention grabbing characteristics. Gradual changes to environmental conditions or aircraft status, such as deteriorating weather, reducing light and gradual speed changes, can be particularly difficult to notice - a phenomenon confirmed in simulator experiments called "change blindness". This can result in poor situation awareness and contribute to PCB. Even severe deteriorations can remain undetected; after pilots have made an original assessment about the safety of a flight, confirmation bias can prevent them from acknowledging cues that indicate that plan is no longer optimal. FSF advocate that pilots must "see to understand", that is, deliberately scan to gain information and compare it with expected or normal parameters.

Dekker (2006) suggested that ambiguous cues can perpetuate PCB because while early cues that everything is OK are often strong, later cues that suggest otherwise are often few and unclear. He says that even if people recognise and acknowledge those cues, they will often not be strong enough to compel a change a plan. For example, cues such as a saturated runway and changeable winds can be contradicted by the successful landings of the aircraft ahead, making it difficult for pilots to recognise the risks of continuing. Another example is pilot induced oscillations (PIO). PIOs can start small, as routine corrections to small deviations, but gradually grow in size as the pilot persists in trying to stabilise the aircraft. This can happen on landing, when the only safe option is to "bug out", however, as the situation deteriorates, pilots are at risk of becoming increasingly fixated on stabilising the aircraft, of getting it on the ground, and failing to 'wake up' to the fact that it is time to get out of there. It's easy to see how this type of situation can eventuate because we are habituated to making multiple small, and occasionally, large corrections to minor deviations from parameters when flying. That acquired skill may in itself create overconfidence and false perceptions that a situation is recoverable. Dismukes et al (2007) suggest that pilots can become trapped in a cycle of serially reacting to each perturbation or event as they occur and correcting as required, making it difficult to realise the combined impact of those factors on the flight as a whole. So at what point have we crossed the line? When have those small, constant corrections become too much, too late? Often, there is no clear dividing line or unambiguous indicators to shake us out of that state.

Not easily mitigated...

The preceding paragraphs have outlined some of the ways that PCB can develop for pilots during the approach and landing. The development of PCB is multi-faceted, gradual, insidious and self-perpetuating. Worst of all, it gets stronger the closer we get to achieving our goals. Going around when an approach is not working out unquestionably demonstrates good judgment, maturity and high personal standards. However, that statement on its own pre-supposes that pilots have first recognised the cues that indicate a go around is needed, which as discussed above, is a naïve assumption to make. Therefore, in order to help pilots avoid the PCB trap to the greatest extent possible, by helping them identify critical cues when a go around should be conducted, specific tools must be advocated and ingrained in pilots. A fundamental requirement is clearly defined stable approach criteria in standard operating procedures, however operational norms can drift away from the formal requirements outlined in company documents. Dismukes et al (2007) suggest that pilots may not appreciate the underlying reasons for apparently conservative stable approach criteria, and may be tempted to apply their own judgment and override those rules when they consider it safe. A cultural shift may therefore be necessary to encourage pilots to think positively about rejecting a landing when necessary, rather then counting the commercial and personal costs. We can all probably recall continuing an approach at some time in our career when the aircraft was "not quite on profile" or "just a little fast". You may have been conscious of the deviations from SOP criteria but unaware of the extent, or you may have considered it reasonable to carry on, happy in the knowledge that the deviations could be corrected in time for a safe landing. Indeed, frequently pilots have submitted reports of unstable approaches and justified continuing through stable gates with one or more parameters not "in the slot" with statements like, "at no time was the aircraft unsafe". Such selfaffirming judgments are indicative of a hazardous drift and a failure to appreciate why stable gates must be conservative. In the Burbank accident, a go around could have been commenced at any point until just after touchdown; the captain briefly considered going around and re-circling but erroneously assessed that he could make it work. In the Bangkok accident, the captain almost did go around, but so compelling was the cue of touching down, that he seemingly couldn't resist the opportunity. The 'catch 22' of PCB is that once pilots have become engrossed in trying to fix a bad approach or landing attempt, there is little cognitive capacity left to properly evaluate all available information and realise that fixing the approach should not be attempted. Compounding this, as workload increases, it gets harder for pilots to even detect their own high workload and recognise when they have become susceptible to these biases.

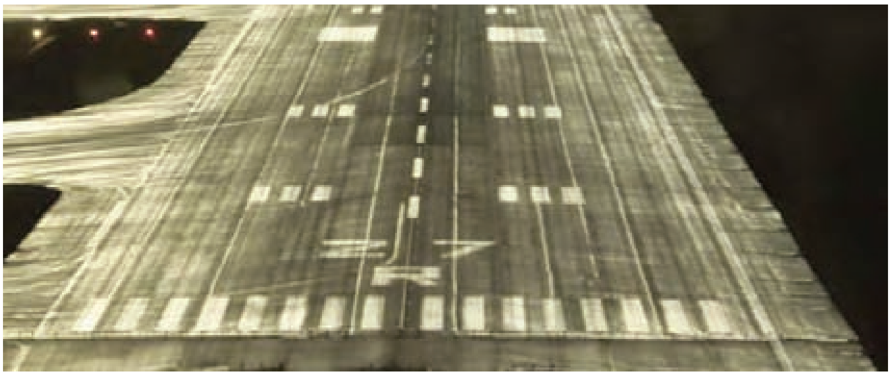
A B747-400 rests in the grass off runway 21L at Bangkok's Don Muang Airport.
The B737-800 left the airport after landing at Burbank, California, 2000.

"In most instances, a runway excursion is not a total surprise to the flight crew. We have proved several times each year that, if you're landing long and fast, with a tailwind, or on a contaminated runway, the consequences are predictable"
James Burin, FSF (Source: ATSB , 2008).

Practical prevention tools:

Communication

Thus, timely and effective call outs about deviations from required stable gate parameters are imperative. Standard deviation call outs do more than simply draw pilots' attention to parameters that they may not have noticed. They can also 'wake up' the pilot flying (PF) to an unsatisfactory situation of which they may have been aware but were persevering to resolve, and put positive pressure on them to do something about it – 'putting it out there' can make the decision easier for the PF. Monitoring pilots can go one step further, in providing advance warning of undesirable energy states prior to reaching the stable gates, by giving the PF time to correct prior to reaching stable gates and avoid the temptation to make it work. Additionally, suggesting corrective actions can strongly influence a PF to act on unsatisfactory indications; for example, "we are too fast, we should go around". It can also be effective to provide values. For example, stating "vertical speed" is good. But "vertical speed, 1800" is better. The PF should indicate

Wet runways and tailwinds are common ingredients in runway excursions

when they are aware of deviations from planned parameters and state their intentions. Effective communication is therefore vital. The PM should never assume that the PF is aware of deviations, no matter how obvious it may seem. Recall that the Burbank FO did not call out deviations to the captain because he appeared to be acting – however, the captain later said he had not realised how bad the situation was. More assertive communication from the PM could well have led to a better result for that crew.

Plenty of prior planning prevents press-on-itis

However, under extreme workload, monitoring pilots may also be suffering attentional narrowing and may consequently miss the very parameters to be called out; hence, no crew should be completely reliant on standard calls to alert them to deviations. It is best, therefore, to avoid those situations in the first place by recognising the types of factors that may be conducive to PCB. Learn to identify the signs of PCB or when workload is high. Dismukes et al (2007) suggest that pilots should be taught how to detect their own workload, for example, if the PM is too busy to perform the landing checklist, then that is in itself an indication that the approach should be discontinued.

Planning plays a vital role. We all know that planning for a stabilised approach starts well before the approach, but do we really practice it? When possible, discuss decisions being made with all crew members and specifically discuss the risks.

More than just briefing stable gates, discuss how they will be achieved and remember that even if stable through the gates, if the aircraft becomes unstable in any way after that point, a go around is required. During briefings, ask the PM to challenge you if you do not go around when any factor warrants it - if they notice that parameters are being exceeded, or if you elect to continue an unstable approach based on an assessment that doing so is "safe' or "justified", these should be recognised as warning flags. Additionally, always keep in mind that ATC have played a role in many runway excursion accidents by positioning aircraft in ways that enable unstable approaches to develop. Therefore, ATC instructions should be declined if they risk putting pilots in situations that will require them to rush an approach.

Challenging weather conditions that can make PCB likely can also be planned for and managed. For example, when poor weather is a possibility on the approach, plan for this in advance by calculating landing distance requirements for the worst forecast situation. If a wind shift is possible late in the approach, plan for that - know the wind limits for the landing distance available prior to starting the approach, so that if the wind changes during the approach, the crew can easily determine if it exceeds the calculated limit. A factor often overlooked is that it is vital to know where the touchdown zones are on the runway – pilots should be prepared to go around if they are overflown.

Be Go Around Minded

Perhaps the most important tactic for preventing PCB is to be "go around minded", as advocated by FSF. However, simply telling pilots to go around when necessary may not be sufficient to ingrain the reaction and build pilots' confidence in performing unexpected go arounds when required. A go around can be necessitated by numerous events, therefore it is necessary to be adequately prepared, in any situation, not just bad weather days, by always expecting a go around. Yet the actual infrequency of go arounds, and pilots' lack of practice and lack of readiness for them, puts them at risk of being mismanaged. Both the reaction and the execution of go arounds must be practiced to become ingrained. Abandoning landing attempts should be frequently practiced in simulator sessions for multiple reasons. Training must reinforce the principle of going around if not stable – landing off unstable approaches should not be tolerated in the simulator. In the absence of simulator practice, regular mental rehearsing and touch drills can be invaluable.

The lessons of runway excursions have largely been learnt already, yet they continue to occur. Plan continuation bias is a natural human tendency that can make even the most conscientious pilots susceptible to the risk of an overrun on landing. There are a number of strategies available to help minimise its effects - the best advice is to actively practice those strategies: train yourself to think positively about going around and plan on going around on every landing, regardless of the conditions.

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Strong Gusty Crosswinds

By Wayne Rosenkrans

Two focused studies challenge today's variations in airline practices and flight crew decision making.

Challenging encounters with strong gusty crosswinds during the approach and landing phase in commercial air transport — never routine for flight crews and sometimes underestimated by air traffic control (ATC) — involve some risk because of systemic gaps, mismatches and misconceptions, says Gerard van Es, senior consultant for flight operations and flight safety, National Aerospace Laboratory Netherlands (NLR).

He explained the impetus for further study of the factors involved and a few of NLR's recently developed recommendations during Flight Safety Foundation's International Air Safety Seminar in Santiago, Chile, in October 2012. In April, van Es updated *Aero-Safety World* about industry responses to the complete report that he and a colleague, Emmanuel Isambert, prepared as advisers to the European Aviation Safety Agency (EASA).[1]

Difficult surface wind conditions[2] have confronted pilots since the flights of Wilbur and Orville Wright, and one of the many recent examples was a serious incident in Germany in 2008 (see "Serious Incident in 2008 Prompted German and EASA Analyses," p. 17) that motivated German accident investigators, and subsequently EASA, to dig deeper into the causal factors and to update mitigations. A German recommendation — calling for assessment of all measuring systems that detect the presence of near-surface gusts and how pilots integrate various wind data into landing/go-around decisions — led to the NLR study for EASA, van Es said.

Crosswind-related regulations originated in a period from a few years after World War II to 1978, when demonstrated crosswind in airworthiness certification regulations became fixed for industry use, van Es said.[3] NLR's scope included querying operators about understanding of aircraft certification for crosswind and relevant policies and procedures; a brief review of factors in crosswindrelated occurrences; a review of measurement technologies; and the salience of wind instrument precision.

"First of all, we noticed that the way of arriving at and presenting the [crosswind] information varies between the manufacturers and even between the aircraft models," van Es said. "Most [manufacturers] don't mention any kind of gusts, but also the way they've derived the [demonstrated crosswind value] during the flight test can be very different, giving different results. And they are allowed to, and the regulations on the means of compliance [allow them] this opportunity. Limits, real hard limits, are very rare, nor are they required to be established. Typically, it's up to the operators to decide if they transfer a demonstrated value into a hard limit. ...This all can result in a possible mismatch [between] what the operator is using and what the data from the manufacturer is telling [us]."

The NLR survey was sent to 115 operators from Asia, Europe and North America, and yielded 36 operator responses. "Basically they were telling a story that we were expecting, to some extent," van Es said, especially regarding the variability in practices. "They were very keen to see what others were doing and what the issues were," given their anecdotal knowledge of many crosswind-related occurrences.[4]

Wind Data Sources

Operators and pilots have several disadvantages as they integrate complex factors. "First of all, there is no common interpretation of the manufacturer's crosswind," he said. "[Respondents] operate similar models, and they have a different view of what was told to them or what was written in the manuals provided to them. When it came to reported gust values in their operation — the wind reports, how to deal with gusts — some operators said, 'We don't take into account the gusts when we look at the reported wind values.' Others said, 'Yes, we do, and we do it this way.'

Others said, 'We do, but we don't specify how to deal with the gusts.'"

Each type of wind information has advantages and limitations. "FMS [flight management system–derived] wind is something that you have to be very careful in using, especially during the approach," van Es said. "[Yet] some operators …said use of FMS wind is encouraged and [indicates] good airmanship. Others said, 'It's strictly prohibited because we had incidents where we nearly lost the aircraft by using FMS winds.'" Problems in relying on this source in this context include lack of system correction for side slip, its use of an average value and its applicability to winds at altitude — not at the surface.

Some respondents' pilots request from ATC a series of instantaneous wind reports during approach. "These are snapshots — the actual [real-time] wind that is available as measured at the airport," he said. "Typically, you get an average [two-minute] wind, but some airports allow you to ask for an instantaneous wind [report]." Some respondents promote the use of instantaneous winds; overall, there was no common way of determining the components either in tailwind or in crosswind.

The survey also found that 75 percent of respondents use a combination of demonstrated and advised crosswinds, and a number of these set maximum crosswind values lower than the manufacturer's demonstrated/advised crosswinds; 82.9 percent use the crosswind values as hard limits; 67 percent have procedures for how their pilots should calculate the crosswind component, with 58 percent of these specifying how the pilots should take gusts into account; and 33 percent do not include gusts in their crosswind values. "A small number of the respondents left the decision — to include gusts or not — up to the captain," the report said.

Risk of Confusion

NLR researchers usually found that in occurrence reports, only the wind data reported on the automatic terminal information service (ATIS) had been considered by the flight crew in preparing for an approach, while all respondents cited control tower wind reports as their primary source. "So the reported wind that they got just before landing was not taken into account [in the occurrence reports]," van Es said. "And what happened in the 30 minutes that [elapsed as they] were planning the approach [was that by] the actual landing, the wind had changed. That happens all the time; the wind encountered is completely different from what is reported. They got a much stronger wind."

Frequently in cases selected, the pilot flying used an incorrect crosswind technique, not following the manufacturer's recommendation. Even low-velocity crosswind/gusts can be very difficult if the flight crew fails to correctly apply the procedure.

Figure 1 from the NLR work gives a sense of the pilots' expectations versus the reality they encountered in comparable models/types of large commercial jets. "For several cases — excursions, hard landing, tail strikes, wing/pod strikes — what we see is that more than half of these occurrences [take place in crosswind conditions that are less than] what was demonstrated," he said.

The two most prevalent wind sensors approved for airport runways with accurate gust-measurement capability are the cup/propeller type with a wind vane, and the ultrasonic type (often called *sonic* type). Both measure data within 2 to 4 percent of the correct value.

"The normal [ATIS/control tower] wind report that you get is an average," van Es said. "It is a forecast of the wind that you're supposed to expect. Many pilots think it is an actual [realtime] measurement; it is not. It is a two-minute average, and they came up with this [to provide users] a good balance between the mean error and the absolute error in the forecast."

The NLR report published by EASA includes a list of recommended mitigations for the issues identified, and van Es discussed some examples. "First of all … include gusts when decomposing reported wind into the crosswind component and take the gust component [as] fully perpendicular to the runway," he said. In the United States in the 1950s and 1960s, this practice was mandatory, NLR found. Flight crews always should use the most recent wind report in decision making.

Despite the willingness of controllers to provide a series of instantaneous wind reports on request during an approach involving strong gusty crosswinds, NLR researchers advise against using this source. "[In] several incidents …the pilot was asking for …the instantaneous wind every 10 seconds," he said. "And [these values] went all over the place until [one was] below his company limit, and then he said, 'Yeah, going to land.' He went off [the runway]."

As noted, applying the manufacturer's crosswind-handling technique for the specific aircraft type/model/size is the best practice in risk management. But even this cannot be 100 percent successful, given the unique and dynamic forces in play. "The poor pilot …is confronted with all kinds of confusion and issues when he has to decide whether or not to land in a gusty crosswind," van Es said. "It should be company policy that you can ask for another runway or divert if you don't feel comfortable — if the

Serious Incident in 2008 Prompted German and EASA Analyses

Freezing rain caused a two-hour delay in the Airbus A320's departure from Munich, Germany, for a scheduled flight with 132 passengers and five crewmembers to Hamburg the afternoon of March 1, 2008.

During cruise, the flight crew received a Hamburg automatic terminal information system report of winds from 280 degrees at 23 kt, gusting to 37 kt. They planned for — and later received clearance for — an approach and landing on Runway 23, which is equipped with an instrument landing system (ILS) approach, said the report by the German Federal Bureau of Aircraft Accident Investigation (BFU).

When the crew reported that they were established on the ILS approach, the airport air traffic controller said that the wind was from 300 degrees at 33 kt, gusting to 47 kt.

The report said that a decision to go around would have been reasonable because the controller's report indicated that the winds exceeded the maximum demonstrated crosswind for landing, which was "33 kt, gusting up to 38 kt" and presented as an operating limitation in the A320 flight crew operating manual.

The captain asked for the current "go-around rate," and the controller replied, "Fifty percent in the last 10 minutes." The controller offered to vector the aircraft for a localizer approach to Runway 33, but the captain replied that they would attempt to land on Runway 23 first.

Figure 1

The crew gained visual contact with the runway at the outer marker. The copilot, the pilot flying, disengaged the autopilot and autothrottles about 940 ft above the ground. She used the wings-level, or crabbed, crosswind-correction technique until the aircraft crossed the runway threshold and then applied left rudder and right sidestick to decrab the aircraft — that is, to align the fuselage with the runway centerline while countering the right crosswind.

The A320 was in a 4-degree left bank when it touched down on the left main landing gear and bounced. Although the copilot applied full-right sidestick and right rudder, the aircraft unexpectedly rolled into a 23-degree left bank. It touched down on the left main landing gear again, striking the left wing tip on the runway, and bounced a second time.

The crew conducted a go-around and landed the aircraft without further incident on Runway 33. The left wing tip, the outboard leading-edge slat and slat rail guides were found to have been slightly damaged during the serious incident, the report said, but the ground contact was not detected by the flight crew.

The BFU, in its final report, listed the immediate causes: "The sudden left wing down attitude was not expected by the crew during the landing and resulted in contact between the wing tip and the ground. During the final approach to land, the tower reported the wind as gusting up to 47 kt, and the aircraft continued the approach. In view of the maximum crosswind demonstrated for landing, a go-around would have been reasonable. System-level causes were: "The terminology *maximum crosswind demonstrated for landing* [italics added] was not defined in the Operating Manual (OM/A) and in the Flight Crew Operating Manual (FCOM), Vol. 3, and the description given was misleading. The recommended crosswind landing technique was not clearly described in the aircraft standard documentation. The limited effect of lateral control was unknown."

In the relevant time period, the surface wind at Hamburg was being measured by German Meteorological Service anemometers located near the thresholds of Runways 23/33 and 15, and was logged at 10-second intervals. Air traffic controllers also had data on maximum veer angle and peak wind speed for the preceding 10 minutes. "In the final 10 minutes prior to the occurrence, the wind direction varied between 268 degrees (minimum) and 323 degrees (maximum)," the report said. "In this period, the maximum gust speed recorded was 47 kt [Figure 1]."

When the controller later gave the crew clearance to land on Runway 33, the information included wind from 300 degrees at 33 kt gusting to 50 kt (two-minute mean value). Four additional wind reports were issued to the crew before touchdown, the final one for wind from 290 degrees at 27 kt gusting to 49 kt.

"The investigation showed that wing tip contact with the runway was not due to a single human error, a malfunction of the aircraft or inadequate organisation; rather, it was due to a combination of several factors," the report said, citing the automatic transition from lateral flight mode to lateral ground mode control laws when the left gear first touched down, resulting in half of full travel in response to full sidestick deflection.

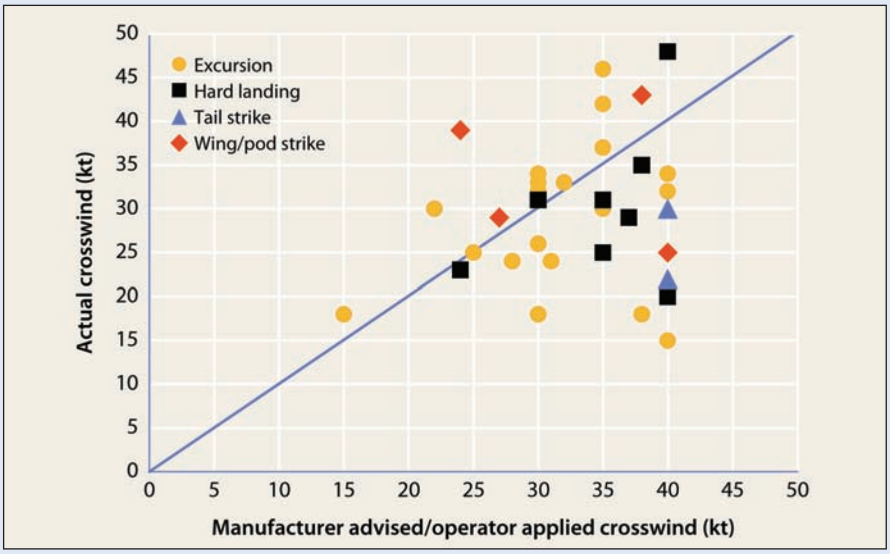
"The fact that there were no significant gusts during the decrab procedure explains that the aircraft was not brought to this unusual and critical attitude by direct external influence. … The BFU is of the opinion that the captain as pilot-in-command did not reach his decision using … reasoning [regarding lower crosswind component on Runway 33], because he did not regard the value maximum crosswind demonstrated for landing as an operational limit for the aircraft. Civil air transport pilots were generally poorly informed about the effects of crosswinds in weather conditions such as these."

During this investigation, 81 pilots holding air transport pilot licenses and employed by five different airlines provided anonymous survey responses in which they were about evenly divided in understanding maximum demonstrated crosswind as a guide versus a limit. Significant differences in understanding also were found concerning the practical application of maximum demonstrated crosswind.

The serious incident involving the Airbus A320-211 at Hamburg on March 1, 2008, and related events were analyzed and safety recommendations about landing in strong gusty crosswind conditions were issued by the German Federal Bureau of Aircraft Accident Investigation in Investigation Report 5X003-0/08, March 2010.

— Mark Lacagnina and Wayne Rosenkrans

Actual Events Involving Strong Gusty Crosswind Conditions vs. Guidance to Pilots



Notes: Occurrences studied by NLR included some that happened when crosswind components exceeded the values in guidance to flight crews, and others below those values.

Source: G.W.H. van Es and Emmanuel Isambert, NLR

Figure 1

wind conditions are unfavorable — because that is a very good defense in these cases."

Since the release of the 2010 and 2012 reports, with further EASA–NLR communication through industry forums and pending articles for airlines' safety magazines, a number of operators say they will revisit their policies and procedures, van Es told *AeroSafety World*. Convincing civil aviation authorities, however, is likely to take more time.

"The regulatory [part] is always difficult in terms of who is taking the lead in this case, especially because it's a multiactor issue," he said, and this involves the initiative of operators, manufacturers, regulators and the aviation meteorology community. "The regulators are hesitating to go left or right. They don't know exactly what to do."

Basically, the problem they face is some degree of mismatch in certification of aircraft versus operational use of aircraft.

"What EASA has said is that they are looking to publish … a sort of safety bulletin on this topic," van Es said. "But changing regulations? I think that's a step too far for them. There are big advantages in educating the pilots because they often have great difficulties in understanding … wind report [sources]. There is a lot of misconception within crews about how the systems work. … The best experience is the real experience, but for an average line pilot, to have a lot of these landings could be quite rare."

Notes

1. EASA. *Near-Ground Wind Gust Detection*. Research Project EASA. 2011/08 NGW. Van Es, G.W.H. "Analysis of Existing Practices and Issues Regarding Near-Ground Wind Gust Information for Flight Crews". NLR Report no. NLRCR-2012-143, October 2012.

2. Citing World Meteorological Organization (WMO) WMO-No. 731, the NLR report published by EASA says, "A gust can be defined as the difference between the extreme value and the average value of the wind speed in a given time interval. A gusty wind is characterized by rapid fluctuations in wind direction and speed. At airports, gustiness is specified by the extreme values of wind direction and speed between which the wind has varied during the last 10 minutes."

3. For example, EASA's internationally harmonized regulation (Part 25.237, "Wind Velocities") states, "For landplanes and amphibians, a 90-degree cross component of wind velocity, demonstrated to be safe for takeoff and landing, must be established for dry runways and must be at least 20 kt or 0.2 V_{SO}, whichever is greater, except that it need not exceed 25 kt. Note that V_{SO} means the stall speed or the minimum steady flight speed in the landing configuration."

4. The report said, "Since 1990, there have been more than 280 approach and landing [accidents] and 66 takeoff accidents/incidents investigated with [Part] 25–certified aircraft operated in commercial operations worldwide in which crosswind or tailwind was a causal factor. Occurrences related to gusty wind conditions are also very common in Europe. …The wind in these occurrences was often very gusty."

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