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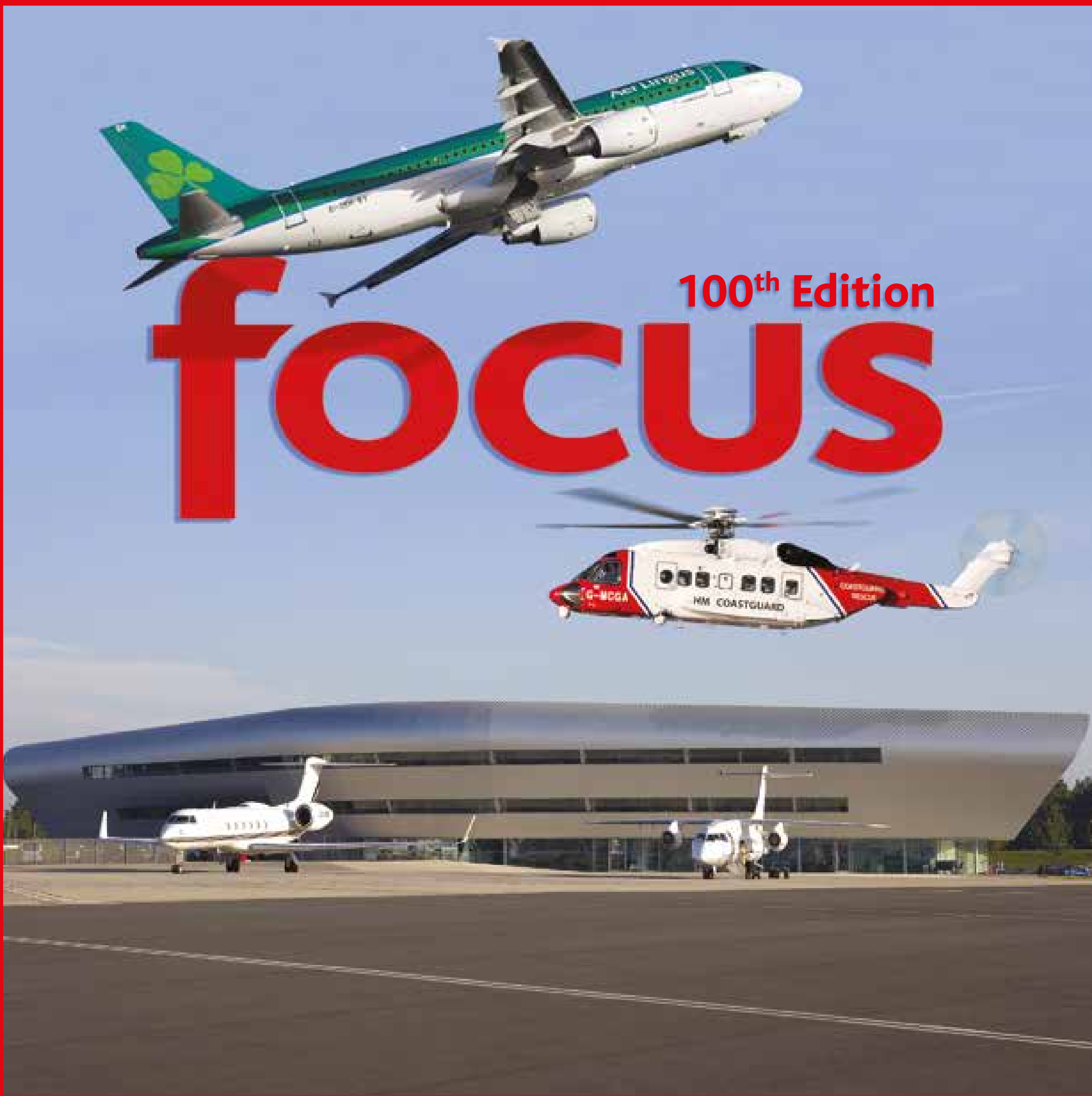

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THE UK FLIGHT SAFETY COMMITTEE

AUTUMN 2015

ISSN 1355-1523

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The Official Publication of THE UNITED KINGDOM FLIGHT SAFETY COMMITTEE ISSN: 1355-1523 AUTUMN 2015

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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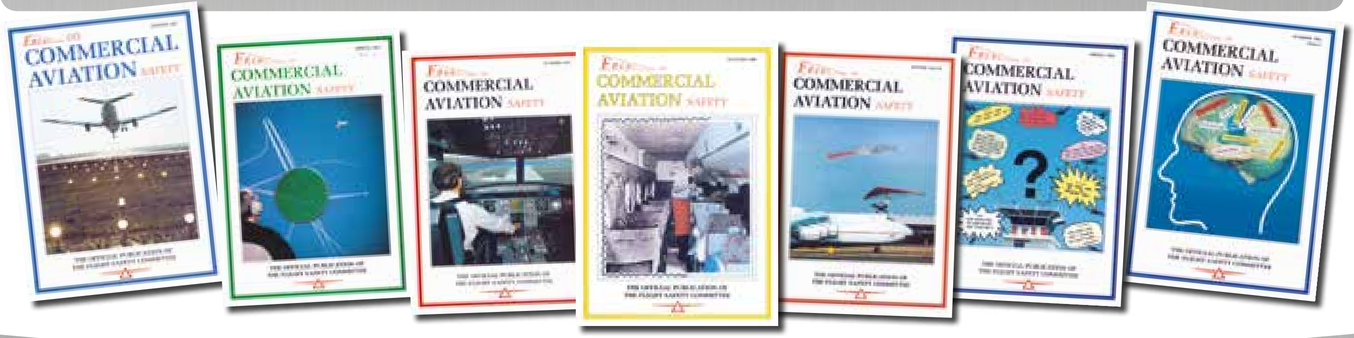
Front Cover: A montage of 2 of UKFSC's earliest members and TAG's terminal at Farnborough, the site of the UK's first powered flight

HOW MANY DO YOU REMEMBER?



100 Not Out

by Dai Whittingham, Chief Executive UKFSC

As you will have noticed from the historical flavour of our front cover, this is the 100th edition of FOCUS in its current form. At 4 issues per year, that means 25 years of providing information aimed at contributing to the safety of commercial aviation. While it would be pointless to attempt to quantify the FOCUS contribution to progress, it would be worth reminding ourselves of what the commercial air transport world was like 25 years ago and looking at what might have changed.

As the first edition of FOCUS was being written, the world-wide web was in its infancy and industry was still absorbing the lessons of the Kegworth and Dryden accidents of 1989. The Moshansky investigation on the F-28 Dryden accident was still over a year away and would change the approach to safety for both regulators and operators. Kegworth brought some changes to airworthiness standards, specifically to the crash-worthiness of overhead bins, but the recent ATR accident in Taiwan suggests we have still not all fully learned the wisdom of having two people agree on which engine has failed and confirming the appropriate actions for shutting it down if that is deemed necessary.

The broad statistics show that the efforts to improve safety have been working. The western-built accident rate in 1990 was approximately 1.4 per million flights. Today, the global rate is 0.5 per million. That would be seen as a success in any terms, but it becomes more remarkable when set against a doubling in traffic over the same period. And for the 4th-generation types (fly-by-wire and envelope protection) the fatal accident rate is only 0.11 per million flights, with a hull-loss rate of 0.23 reflecting the ever-present danger of runway excursions. The trend lines are still descending, though the media view on MH370, MH17 and Germanwings would of course have us think otherwise.

CFIT accidents featured regularly in 1990. For example, an A320 landed 2300 ft short of the runway at Bangalore in day VMC, with more than 10K visibility, killing 92 of the 146 people on board. Tuxtla Gutierrez airport saw an F27 hit trees on the approach with fatal results, and an Alitalia DC9 hit the ground 5 miles short of Stadlerberg having descended 1400 ft below the ILS glidepath. Glass cockpits, better FMW, GPS and increasingly effective GPWS systems have helped to generate a 7-fold reduction in CFIT accidents, but they still occur too often, sometimes when crews have ignored all the warnings the automated systems have been giving them. The UPS A300 accident in Birmingham, Alabama, two years ago resulted from what had become a ‘dive and drive’, unstable approach; the crew had the runway in sight but did not appear to have been monitoring either their altitude or rate of descent, nor did they recognise the approach was unstable while a go-around would still have saved them. CFIT may well replace LOC-I as the leading cause of fatalities once the current focus on UPRT works its way through the pilot community. Hopefully the initiatives to improve flightpath management skills will have a positive effect on both CFIT and LOC-I occurrences.

Whilst some themes remain constant, there is no denying that the aviation world today is very different from that of 25 years ago. The collapse of communism and increasing globalisation driven in part by the internet has seen an explosion in the numbers of destinations now being served by commercial aviation. Many of these destinations are ex-military airfields, a tangible sign of the so-called peace dividend – despite the fact that the world is arguably less stable now than it was before the Wall came down. So while there is a much increased choice of destination, there are certainly many more conflict hotspots that add to the risk of over-flight, or of operating into nearby destinations, as MH17 has proven so graphically. In the early 90s it was reasonable to assume that heavy weaponry was under strong control, but that assumption is no longer valid for all areas.

Passenger numbers and the success of low-cost operators are ample evidence of the fact that flying is no longer the preserve of the wealthy. Demand seems to be recovering well following the economic crash in 2008 and the manufacturers appear to have reasonably healthy order books. But demographics are changing and there are increasing concerns being expressed about the ability of the industry to train enough pilots and aircraft engineers to support the forecast demand. As one of the unexpected consequences of the financial pressures that followed the melt-down of the world banking system, the cost of training is now being borne principally by those being trained. It cannot be right that the primary filter for entry to the profession is not aptitude, or intellect, or medical fitness, but is instead the size of a candidate’s wallet.

Financial pressures have also contributed to new business models such as ‘pay to fly’ and zero-hour contracts. Pay to fly is a particular concern as it places real pressure on individuals to fly when they are not fit through illness or fatigue, the fatigue often arising from the need to have a second job to control the level of personal indebtedness. A further result of the squeeze has been a reduction in manpower and more pressure to get the maximum out of crews, which leads to some rostering practices that are legal but not perhaps sensible. Flight time limitations have become targets rather than limits, which means that a large proportion of the pilot and cabin crew communities are operating at maximum capacity all the time. We are now seeing some very experienced pilots opting to work part-time as a defence against long-term fatigue, which is a warning sign that should not be ignored.

Aircraft are much more reliable now than they were 25 years ago, which is testament to the efforts that the airframe, engine and avionics manufacturers have made to improve their products. As part of those improvements the industry has seen increasing levels of automation. While there is no doubt that automation has contributed significantly to a reduction in the accident rate, there is understandable concern about the dangers of over-reliance on automation and on the atrophy of manual flying skills. The younger generation of pilots have been immersed in computer technology since childhood and trust it implicitly, but those attitudes tend to prevail now across the pilot community, a function of the reliability of avionics and autopilots coupled with the normal human tendency to accept anything that makes life easier. Small wonder then that gross errors generated at the data entry stage are sometimes not detected until it's too late. Similarly, TCAS has worked wonders for awareness of traffic and for collision avoidance, but as another example of an unintended consequence of change it has also largely removed the incentive for pilots to look out of the flight deck despite 'see and avoid' being the last line of defence.

As for other changes, it is now almost 14 years since the 9/11 attacks brought us the armoured and locked flight deck door along with major changes in security arrangements. It will never be possible to know how many other terrorist attacks or hijacks have been prevented by the presence of the flight deck door, but its impact on communications between pilots and cabin crew has been manifest on many occasions. We will also never know how many young people failed to try for a career in aviation because they were never inspired by a visit to a working flight deck; hopefully we will still be able to attract the half-million pilots and engineers that some forecasts suggest will be required over the next 15 years.

One of the major changes since 1990 has been growth in the use of space-based navigation systems, both in the air and on the ground. The proliferation of RNAV approaches seems to be accelerating and yet the ATM environment becomes ever more complex and congested. A bewildering array of approaches is now available for most runways, the tendency being to add options rather than simplify decision making. It is now too easy just to follow the decisions taken by the nav system, on the normally correct basis that the kit is right. Electronic flight bags have become the norm and the use of data-links is now routine business for CAT. Complexity is rearing its head in other areas as well, with the pace of change in regulation and operating instructions being hard to keep up with. Electronic manuals offer managers the opportunity to make rapid changes to documents and procedures, but the danger is of a significant change being lost in the noise of sometimes daily alterations of a minor nature. Such is the price of progress.

Passenger behaviour has been a common theme across the last 25 years – it was raised in the very first edition of FOCUS. It is perhaps becoming more prominent as an issue because of increasing numbers of passengers, the added frictions from security processes and constraints on the use of personal electronic devices, and a willingness to prosecute the worst offenders. In societal terms there is less deference being shown to those in authority, which may go some way to explaining why passengers being evacuated in an emergency will still try to take hand luggage with them despite being told not to, and why some will refuse to comply with legitimate instructions from crew members. It is a problem that will not go away quickly, if ever.

Lastly, it is worth remembering that threats change with time as well. Lasers have been with us for a while but available power levels are increasing, as are raw numbers of hand-held devices. It is now possible to buy cheaply a 5W green laser that is capable of causing disabling eye injuries at 250m range; the easy availability of such devices has to be a concern to us all, and the UKFSC is working with others on measures to control the problem in the UK. The other new threat is from the proliferation of remotely-piloted air systems (drones) and their seemingly un-controlled proximity to other aircraft. Many small drone operators are ignorant of the airspace in which they fly, of the regulations that pertain to their operations, and of the risk they pose to others when they are airborne. That too has to change; hopefully the cross-Government strategy now in development will help to control a problem that is already being seen in the rising numbers of drone encounters being reported by flight crews.

So, a skim across the last 25 years and a little look at the future by way of celebrating the first 100 issues of FOCUS. If you would like to contribute to the next 100 issues by providing us with an original article, we would love to hear from you.

HOW MANY DO YOU REMEMBER?

Justice or a dark day for flight safety?

by Capt Chris Brady, Chairman UKFSC

On 19 June 2015 Lord Jones at the Court of Sessions in Edinburgh ruled that the CVR and FDR for the accident to helicopter Super Puma G-WNSB at Shetland in 23 August 2013, should be released by the AAIB to Police Scotland. They will in turn ask CAA SARG to provide an expert opinion on the performance of the flight crew during the accident flight. To quote the judgement precisely:

"In my judgment, there is no doubt that the Lord Advocate's investigation into the circumstances of the death of each of those who perished in this case is both in the public interest and in the interests of justice. The cockpit voice recording and the flight data recording which the Lord Advocate seeks to recover will provide relevant, accurate and reliable evidence which will enable SARG to provide an expert opinion of value to assist him in his investigation of the circumstances of the death of the four passengers whose lives were lost, and his decision whether and, if so, against whom to launch a prosecution. For that reason, the disclosure of the CVFDR will bring benefits for the purpose of the Lord Advocate's investigation. It is important to stress that the analysis of the recordings in the CVFDR for the purposes of its opinion will be carried out by personnel within SARG who have the expertise and experience necessary for the performance of these tasks."

This judgement is disturbing for several reasons:

1. The AAIB investigation is not yet complete.
2. The release of CVR/FDR to an agency other than the AAIB for anything other than exceptional circumstances (such as say a Germanwings type event) is contrary to the way that industry understands the legislation. This may in turn erode the trust that the pilot community has in the safety investigation system thereby undermining any Just Culture that the industry has tried so hard to engender.
3. The use of CVR/FDR by Police Scotland via SARG "to provide an expert opinion on the performance of the flight crew" suggests that the focus of any potential prosecution will be on the pilots, rather than looking deeper into the reasons why two highly trained and experienced professionals may have made an error, (if they did). Reasons such as human factors, training, SOPs, aircraft design, aircraft or airfield equipment shortcomings, ATC, weather, commercial pressure, company or national culture etc. could have been causal or contributory factors.
4. This judgement is indicative of the wider issue of the criminalisation of air accidents.

Why the investigation?

To try to present this particular case in a balanced way it is necessary to give some background to the specifics of the case. The first question is why is there a police investigation at all?

This accident occurred is Scotland where the legal system is different to that of England and Wales.

"The Lord Advocate is responsible for the Procurator Fiscal's investigations into potential criminality and prosecutions. He also has sole responsibility for directing the investigation of deaths in Scotland. In respect of every matter of fatality reported to the Procurator Fiscal, the petitioner directs that the Fiscal must investigate the full circumstances of the death and must also consider if criminal proceedings are appropriate. Such investigations are in the public interest."

The Lord Advocate states that "Given that the four people who died in the crash died in the course of their employment, the deaths will be the subject of a mandatory Fatal Accident Inquiry."

So, from the above we can see that, in Scotland, an investigation into any potential criminality must occur.

It appears that the Lord Advocate has decided that, in the absence of an AAIB report, given that the 3 special bulletins released by the AAIB have suggested no technical failure, that the flight crew may have been at fault. He has therefore instructed Police Scotland to start an investigation along those lines. One item of "best evidence" for such an investigation is the CVR/FDR hence the Lord Advocates petition to the Court of Sessions (the supreme civil court of Scotland) to get their release from the AAIB.

Just Culture

The petition was heard by the Honourable Lord Jones, a former RAF Phantom pilot. BALPA and the crew joined the process as interested parties, to oppose the application. There were also affidavits from Keith Conradi, Chief Inspector of Air Accidents at the AAIB, expressing concerns that release of CVR/FDR was contrary to Article 14(3) of Regulation EU 996/2010 and also from Rob Bishton, CAA Head of Flight Operations within SARG which included the following:

"Mr Bishton expresses the view that a feature which is key to the successful implementation of safety regulation is to achieve an open and honest reporting environment within aviation organisations, regulators and investigation authorities. The effectiveness of that reporting culture depends on how organisations manage blame and punishment. Only a small proportion of human actions that are unsafe are deliberate and deserve sanctions of appropriate severity. A blanket amnesty on all unsafe acts, however, would lack credibility and could be seen as contrary to the interests of justice. What is required, suggests Mr Bishton is a system of "just culture", which creates an atmosphere of trust in which people are encouraged, or even rewarded for providing safety-related information, but in which they are also clear about where the

line is to be drawn between acceptable and unacceptable behaviour."

The Lord Advocate responded in his petition that:

"Just Culture is not intended to be a culture in which those involved in civil aviation are free from scrutiny or investigation."

Nobody is suggesting that those involved in civil aviation should be free from scrutiny or investigation. This is covered by the definition of Just Culture which is defined in Commission Regulation (EU) No 691/2010, Article 2, as follows:

"'Just culture' means a culture in which front line operators or others are not punished for actions, omissions or decisions taken by them that are commensurate with their experience and training, but where gross negligence, wilful violations and destructive acts are not tolerated;"

So the line between acceptable and unacceptable behaviour is gross negligence, wilful violations and destructive acts. Therefore, the prosecution of pilots should be reserved for such cases rather than for weaknesses in human performance or errors, especially if they are system induced and the crew took reasonable decisions commensurate with their experience and training. A problem with having non-experts (ie not the AAIB) investigate this, or any other case, is that any system-induced human performance errors may appear at first sight to be negligence but they will often involve reasonable decisions and understandable errors. The test of negligence is an assessment of what a 'reasonable person' could have been expected to do in the same circumstances, this is usually taken to mean a similar pilot of similar experience and training, often referred to as a substitution test, this again is where expertise is required.

FDM

An interesting side-line to this story is the issue of FDM. The Police request was initially not for the CVR/FDR but for FDM on 22 January 2014. It appears that CHC choose to abide by their FDM agreement with BALPA that restricts the distribution and use of FDM data. The Police then choose not to pursue the FDM data but seek the CVR/FDR. On the subject of release of FDM the Lord Advocate stated in his petition that:

"It is averred that disclosure of the material sought in the petition would be contrary to the terms of the FDM Agreement and have an adverse effect on the functioning of the FDM Programme. It is respectfully submitted that the FDM Programme and Agreement are of little or no relevance to the issues before the Court. The FDM Agreement may, as the interested parties aver, be binding in contract as between BALPA and CHC. However, it does not, and could not, preclude the granting of the order sought in terms of the petition if the Court is satisfied that the relevant statutory requirements are satisfied".

The Law(s)

Those of us in the industry are familiar with the applicable laws surrounding accident reporting and investigation. However some may not be aware that they do permit the disclosure of CVR/FDR under certain circumstances as follows:

ICAO Annex 13 of the Chicago Convention contains the following:

"3.1 The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability."

"5.12 The State conducting the investigation of an accident or incident shall not make the following records available for purposes other than accident or incident investigation, unless the appropriate authority for the administration of justice in that State determines that their disclosure outweighs the adverse domestic and international impact such action may have on that or any future investigations".

EU 996/2010 echoes Annex 13 very closely in Article 14 Protection of sensitive safety information. However it also allows for disclosure of CVR/FDR as follows:

"3. Notwithstanding paragraphs 1 and 2, the administration of justice or the authority competent to decide on the disclosure of records according to national law may decide that the benefits of the disclosure of the records referred to in paragraphs 1 and 2 for any other purposes permitted by law outweigh the adverse domestic and international impact

HOW MANY DO YOU REMEMBER?

that such action may have on that or any future safety investigation. Member States may decide to limit the cases in which such a decision of disclosure may be taken, while respecting the legal acts of the Union."

Finally there is Regulation 18 of The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996, which is again similar to EU 996/2010 and Annex 13. It was under this regulation that the Lord Advocate sought the order.

To summarise, these laws do allow for disclosure if the interests of justice outweigh any adverse domestic and international impact on future accident investigation. This, I would suggest, is where it becomes subjective and where the opinion of the aviation community diverges from the courts.

The Lord Advocate stated that...

"The suggestion that disclosure of the CVR and FDR "would have an adverse impact on future investigations into civil aviation accidents, incidents and occurrences in general" has no evidential basis and is nothing more than speculation (see, in this connection, Société Air France v NAV Canada 2010 ONCA 598, per Goudge JA at §29)." [This refers to the Air France A340 overrun at Toronto]

Lord Jones has had to decide if release of the CVR/FDR would have any adverse impact; he did not forsee any but I am not convinced. The criminalisation of accidents, particularly if driven by the compensation culture, is an insidious malaise which drives behaviour away from openness towards an unhealthy defensive attitude which stifles reporting and hence progress in flight safety. Whilst canvassing opinion from my peers on the line, one pilot said that "Satisfying a short term punitive objective at the expense of long term flight safety benefits will, to reduce it to its starkest terms, "compensate" a few but kill many more." It is difficult to disagree with this viewpoint.

The above legislation, that allows under court orders for CVR/FDR data to be handed over, should only be invoked in exceptional circumstances, otherwise a precedent is set and it becomes the norm and trust is lost. I would not consider the lack of evidence of a technical failure for an incomplete investigation to be an exceptional circumstance.

I also firmly believe that the timing was premature. The Judge could have reserved judgment until after the AAIB Report was published. The safety investigation could be completed without interference and the prosecutor would then have an expert opinion on the cause of the crash to inform his decision on criminal activity.

I have tried to present a balanced view of the judgement but inevitably with such a detailed case the areas I have chosen to quote may be seen by some as selective; and of course as a pilot, I may have an unconscious bias. For that reason I recommend that members read the judgement of Lord Jones themselves. He has done a remarkably thorough job of unpicking all of the various overlaying national and international laws and deciding upon the merits of the arguments of the Lord Advocate, the crew, BALPA, AAIB and the CAA. It should also be said that he has also imposed a very strict set of conditions on the release of the data including appropriate redaction if any transcript is published. The full judgement is available on-line at https://www.scotcourts.gov.uk search under "Court of Session Judgments" using reference P628/14.

I fully understand that the law requires an investigation into any potential criminality given that four passengers lost their lives. However we should leave the reading and analysis of CVR and FDR to the acknowledged, impartial, experts in whom we can trust to get to the real root causes of what are usually incredibly complex chains of events and who will publish their conclusions and safety recommendations in line with international best practices. The judiciary can then take such a report into consideration. The alternative is to have non-experts sifting through CVR/FDR to identify an honest mistake and closing the case as pilot error with the potential for litigation against the flight crew; with it destroying years of trust between pilots and investigators which has yielded so much valuable safety information to make this industry as safe as it is today.

Helicopter Emergency Medical Service (HEMS): A life-saving operation

by Zoe Reeves, BALPA's Flight Safety Officer

"Fairoaks Information Helimed six zero alpha."

"Helimed six zero alpha Fairoaks Information, pass your message."

"Fairoaks Information Helimed six zero alpha, request to transit your ATZ and traffic information en route to a scene along the M25 near junction 10."

Receiving this kind of call from an air ambulance would be thought provoking. I would sit in the tower knowing that the scene of the accident was not far away from my ATC base at Fairoaks and I often wondered how everything would turn out for the people involved.

The air ambulance would be deployed to an incident site of a serious accident where the area is not easily accessible to vehicles or when time is of priority to save a life.

You never know when you may need the help of the air ambulance. I tend to hear about it going to help injured mountain bikers or horse riders quite frequently, being involved in both sports myself. These activities tend to be in remote areas and when things go wrong in the biking or equine world they can go very wrong, very quickly.

Life-Saving Innovation

The first air ambulance in the UK flew into operation in 1987. Since then, the story of helicopter emergency medical services (HEMS) in the UK has been one of sustained expansion, life-saving innovation, and heart-rending personal stories. Now there are more than 30 air ambulances flying nearly 20,000 missions every year. The air ambulance charities in the UK generate over £45 million a year, mostly through donations and sponsorship by local people and businesses.

Emergency Aircraft

Last July I had the pleasure of having a tour of the Kent, Surrey and Sussex Air Ambulance at its Redhill base in Surrey.

The Kent, Surrey and Sussex Air Ambulance Trust's (KSSAAT) state-of-the-art helicopter emergency medical service aircraft operate 365 days a year out of the bases of Marden, Kent and Redhill, Surrey. They are capable of delivering their crews anywhere within the region in under 20 minutes' flying time. Occasionally weather prevents the aircraft flying, so crews also have rapid response vehicles to maximise their availability.

Each aircraft is crewed by at least one experienced pilot and a minimum of one doctor and one paramedic, who are trained in advanced pre-hospital care, which gives them the knowledge and skills necessary to assess and stabilise critically ill and injured adults and children. This means that specialist clinical procedures that are normally only available in the resuscitation area of an emergency department can be delivered to patients at the scene, such as general anaesthesia, advanced pain relief and, for some patients, surgical interventions. Effectively, what they aim to do, as far as possible, is to bring the emergency department to the patient and then take them quickly and directly by land or air to the most appropriate hospital best able to treat their injuries.

HOW MANY DO YOU REMEMBER?

KSSAAT works very closely with the South East Coast Ambulance Service NHS Foundation Trust (SECAmb), responding to over 2,000 emergency calls a year. The normal operating area of the charity is therefore defined by the region that SECAmb covers and includes Kent, Surrey, Sussex, and a small area of north Hampshire; this region has a resident population of 4.5 million people.

The air ambulance is deployed by HEMS paramedics working on the HEMS desk at the control centre of SECAmb, who screen all 999 emergency calls coming into the ambulance service to establish if the air ambulance would be of benefit to the patient.

MD902 Explorer

The charity has been flying a MD902 Explorer helicopter in Kent since the beginning of the century, registration G-KAAT. When the service was expanded into Surrey and Sussex the obvious choice for the second helicopter was another MD902, registration G-KSSH. This has since been replaced with a night-capable MD902, registration G-KSSA.

The MD Explorer helicopter was one of the first designs to incorporate the unique NOTAR system. This means that the helicopter does not have a tail rotor. Instead it has an enclosed fan which directs air through the tail boom to the thruster and out of slots, using the Coanda effect for yaw control. The benefits of this system are increased safety, lower noise levels, better performance and controllability enhancements.

The helicopter has twin engines and travels at speeds of up to 150mph, essential for a rapid response to serious medical traumas. The 902 is still one of the most advanced aircraft available for air ambulance work, and the combination of this and the skills and experience of the pilots allows the helicopter to land in some of the most challenging locations to respond to medical emergencies.

Night Operations

Since September 2013 KSSAAT has been operating at night. To enable the crew to do this it operates its night capable aircraft G-KSSA along with night vision goggles (NVG). The visibility using the goggles greatly improves the safety of the operation but at £17,000 a pair they are not cheap!

There are some hurdles that do restrict this type of operation however, the main one being that there is only one major trauma centre, Southampton, which is within the aircraft's flying zone that is equipped to accept helicopters at night.

There are two major trauma centres in London that have helipads, St George's Hospital and the Royal London Hospital. Neither of these is available for night-time operations. To get around this problem, if the air ambulance is deployed at night it will land at the scene of the accident and blue light the patient to the most appropriate trauma unit along with the medical team that treated them from the aircraft to maintain continuity for the patient. The flight crew will then take the aircraft back to its base at Redhill. King's Hospital in London is in the process of raising funds to build a helipad, which should be in place by spring/summer 2015. It is not yet known, however, if it will be night equipped.

Fuel is also an issue, as away from the helicopter's base, the fuelling infrastructure is challenging.

The medical team at KSSAAT has long been faced with the difficulties of stabilising patients at the scene of an accident who have suffered catastrophic bleeding.

During the early months of 2012, KSSAAT committed to exploring the possibilities of carrying blood on board their aircraft for the benefit of these patients.

The blood safety and quality regulations (2005) are incorporated into UK law and are upheld by the Medicines and Healthcare Products Regulatory Agency (MHRA). The regulations stipulate that blood products must be fully traceable from donor to recipient and that they are stored at a constant temperature, between two and six degrees centigrade. If KSSAAT was to fulfil its aspirations to carry blood on board its aircraft, then compliance with the regulations would have to be ensured. For KSSAAT there was the need to source a

supply of the blood product and a transport solution that would ensure a consistent supply to its bases.

Service by Emergency Rider Volunteers (SERV) is a charity that supplies an out-of-hours blood transport service to the NHS which is free of charge. They agreed to provide a transport service for KSSAAT, servicing both the Redhill and the Marden bases 365 days a year.

Critical Care

Arrangements were made for blood to be supplied by two neighbouring hospitals. East Surrey Hospital would provide blood products to the Redhill base, and the William Harvey Hospital would do the same for the Marden base. Two new pieces of equipment were introduced to support the regulations around temperature control and safe administration. The Credo EMT ‘Golden Hour Box’ is an insulated transport box that can maintain the required cold temperatures for up to 72 hours, and the Belmont Buddy Lite fluid warmer is a light, portable, battery-powered warmer that would efficiently warm the cold blood to near normal body temperatures. A supply of the boxes was made available to the haematology teams at both hospitals. Extensive training was provided to all involved, and on the evening of the 3rd February 2013, two Credo boxes packed with four units of O negative blood, were delivered by SERV to a secure drop-off point at each of the KSSAAT bases, and blood was available to the medical teams for the first time from 7am on the 4th February 2014. The equipment used to carry out this service was funded by the Henry Surtees 2015 Foundation, founded by legendary motor racing champion John Surtees OBE.

As I left the Redhill base that day I felt very lucky to have such services here in the UK. To see that most of the operations around the country are funded mainly by public donations and run by charities is amazing. If you can help support your local air ambulance charity I would encourage you to do so as you just never know if you or a loved one may need their help one day.

For further information on Kent, Surrey and Sussex Air Ambulance visit www.kssairambulance.org.uk.

Original article by Zoe Reeves published in BALPA’S The Log Magazine Winter 2014 edition.

HOW MANY DO YOU REMEMBER?

Bringing Thinking Back into the Automated Flightdeck – Training Resilience With Simple Simulation

by Captain Mark Cameron

Since the 1940's, the emergence of procedural instructions for the operation of increasingly complex aircraft has made a substantial contribution in reducing the accident rate. With multi-crew operations, the formalization of issuing Standard Operating Procedures (SOPs) has had a further beneficial effect, one pilot is more able to predict what the other will do, if the predicted action is missed or omitted, the Pilot Monitoring (PM) is able to intervene. However there are signs that some pilots are having difficulties making sense of events outside of the routine, there are also concerns that the reassurance of procedural compliance trumps resilience.

As an active line pilot for the past 35 years, I have been primarily interested in human behavior and the cognitive processes that form our interaction with the aircraft, especially mine.

Starting with the Bell 47 helicopter, the tiny instrument pedestal surrounded by a large Plexiglas bubble hinted at how the designer intended flight operations to be conducted. Nonetheless, with a power-on engine RPM band of 3000 ±100, there was a tendency for the novice student to spend what felt like 90% of their time fixated on this single parameter. Eventually, within a short time, other senses came to the rescue. If the RPM was drifting high or low, it became possible to hear the change. From those slightly naïve days of visual operations, I now operate an aircraft where the thrust levers do not move with power changes while operating in instrument conditions.

High Fidelity Simulation?

An invaluable component of training pilots to manage their craft has been the simulator. From the early days of the Link Trainer, pilots have practiced and exercised their skills at translating the indications on their instruments into a situational mental model. With increasing powerful and cheaper digital computers the capability of rendering high fidelity external imagery arrived. The simulator manufacturers continue to strive towards 'increasing realism' to make their micro environments even more plausible.

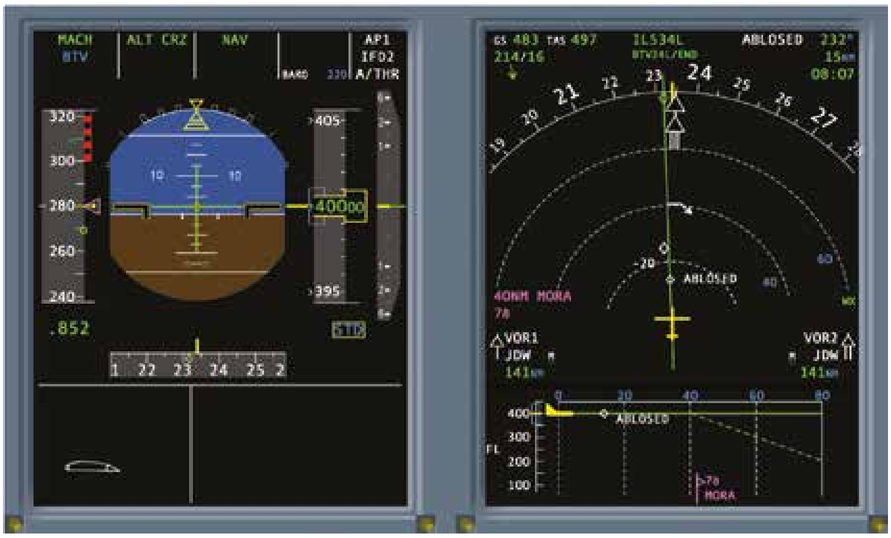


Figure 1. "What's the problem?"

As someone who used to train pilots in a 'live' helicopter, having the ability to safely exercise differing failure modes in a simulator is a huge improvement; it becomes possible to present realistic failure scenarios without having the safe flight trajectory occupying a considerable part of the instructional process, never mind the increased risk and exposure.

However, there are limitations to the current simulator iteration. For example there is still the difficulty of creating a cognitive replication of a naturalistic line flight. When I do any simulator training positioned in a virtual London Heathrow or New York JFK, there is the immediate and detectable implausibility of being the only aircraft in the sky. The only exception to this is when the regulator requires the training or checking of a TCAS manoeuver. As a second example, the scenario in Figure 1 is a case in point; it remains beyond current simulator recreation. This event was taken directly from a line flight and it illustrates the difficulty that the crew is about to face. Even without Airbus experience the reader can try and deduce what the problem is. An explanation will be found at the end of this article.

A further influence of the simulator process is the training and examination of compliance with procedures. As indicated before, these SOPs are central to the safe conduct of flight, however with the increasing levels of safety that results there is the attached paradox of compliance versus resilience. To be provocative it could be suggested that the difference between resilience and violation is simply the outcome. Airlines would like their pilots to follow procedures, the measured operational risk drops as a result, however since procedures cannot address every possible eventuality, there comes a time where a novel event occurs for which there is no procedure. There is little doubt that airlines would also like their crews to insulate flight operations from unpredicted hazards.

Simulation and Compliance

Conversion and recurrent training tend to have footprints; this is a natural extension from the contention made by the airframe manufacturers of the familial structure in their systems design. Common Type Ratings expose the trainees to 'differences' from the archetype. This proscribed strategy tends to generate lists of events that have to be trained or checked to satisfy regulatory compliance. As a result the "44 items in four hours" process can emerge, with a simulator system reset in between each (nearly) completed item. In the past Line Orientated Simulation was held up to fulfill the promise of simulated naturalistic training, but regulatory compliance inhibited this more free-ranging strategy.

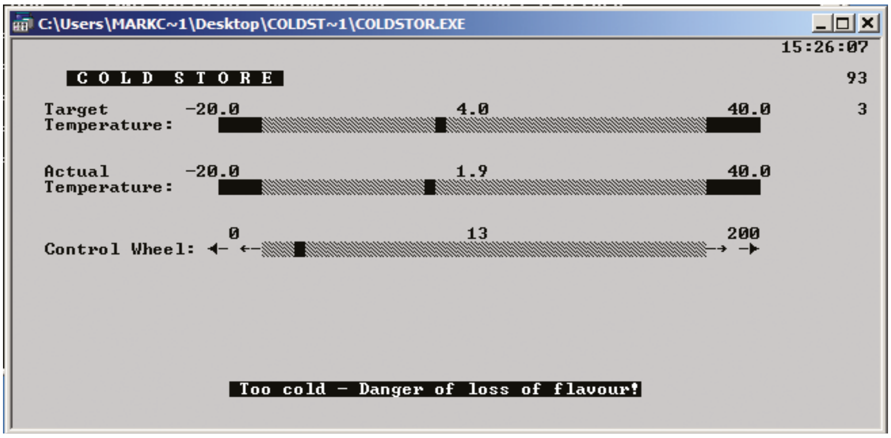


Figure 2. Coldstore Simulation Interface

Industry is offering Evidence Based Training (EBT) as a way of reassuring regulators that training and checking would provide a competence regime 'at least as safe as' previously existed, while moving away from the 'box ticking' routine that still pervades. The difficulty with this move is exemplified by the differing views between the LOSA Collaborative compared to those held by individuals such as Sidney Dekker; the former offering event data collection as a way of assessing operational risk, while the latter worries that 'counting stuff' does not offer any predictive indications of future hazard interactions.

Other Simulations

As part of our CRM departmental development, our manager, Dr. Nicklas Dahlström introduced us to a simple simulation created by a German academic group under Professor Dietrich Dörner. This scenario is designed to exercise the team dynamics that emerge when a group is given the task of running a small cruise ship somewhere in the North Atlantic. This event had such a strong impact on me that I was inspired to use one of these simulations as part of my Masters research. Dr. Dahlström introduced me to Dr. Stephan Strohschneider who, as part of the Dörner group, kindly gave me access to a simple simulation called "Coldstore".

The premise of the "Coldstore" simulation is very simple. The automatic temperature controller of a supermarket coldstore has failed; there is a manual system that can be used in this eventuality. This mechanism consists of a slider or control wheel marked from 0 to 200; the indexes are not correlated to the temperature of the coldstore (Figure 2). At the beginning of the exercise, the coldstore temperature is +18°C and rising, it should be +4°C. The system is already issuing dire warnings of decomposing stock. The task of the subject is to find a setting on the control wheel that will yield a stable temperature of +4°C within a limited period of time.

The typical response of the subject is to intervene in the immediate crisis by adjusting the temperature wheel to a lower setting. The subject then discovers the meaning of a 'dampened phugiod' as initially nothing happens since the still increasing temperature in the coldstore has to be suppressed and then reduced. The size of the system that is being controlled is not always apparent to the subjects; none of my experimental group had worked in a supermarket in a previous life and so the expertise was beyond direct experience. With the initial apparent lack of response to the initial input, the next stage usually followed a typical path of a more adventurous reduction on the control wheel closely followed by genuine surprise as the powerful cooling system overcame the temperature inertia. The system temperature decreases rapidly and the control panel emits complaints of freezing stock (too cold is as bad as too warm with dairy products). The subject then typically readjusts the control wheel in a fashion that will be familiar to pilot trainers and trainees in the first few career minutes of attempting straight and level flight.

Simple But Clever

For such a simple, single axis simulation, it remains remarkably nuanced. The temperature of the coldstore is not contiguous; a temperature snapshot is released every eight seconds, the subject has to wait to see what the response is. This waiting for rationed data can produce some interesting effects. The other remarkable aspect to the simulation is that it can generate data. A small text file is created after each simulation run that can be used to graph time against control wheel input and resultant coldstore temperature. This data capture was useful for producing statistical

HOW MANY DO YOU REMEMBER?

Figure 3. Coldstore Simulation Record

as well as a unique visual illustration of the subject's interaction with the simulation, as can be seen from Figure 3.

Observing Mental Processes

Within the graphical dataset where there appears to be three distinct phases: chaos, learning and mastery. In the initial stages of the simulation, the subject is uncertain of what to do except drop the temperature. The time pressure to solve the problem combined with uncertainty about the relationship between wheel position and temperature lead to rapid but incoherent wheel inputs. As the simulation progresses a solidification of mental model seems to occur; the subject develops their "Theory of System" and then experiments with the control wheel to either validate or disprove that idea. Typically the subject arrives at a tentative but valid theory and after some time will achieve the required parameters. Once the theory seems to hold, the adjustments to the control wheel become more carefully modulated with one or two index unit adjustment to trim the system to the final target temperature.

Other Solving Strategies

Occasionally, with the inertia of the system, the subject will increase the temperature demand on the control wheel and the system, still in a downward cycle will generate a reduction of temperature that completely collapses the still fragile mental construct. Several time cycles can pass before there is confidence to return to the original thesis or another theory is embarked upon.

There is another subset of subjects that could not rationalize the system in any way, they constantly chased the temperature up and down the scale; in his book "The Logic of Failure" Dörner labeled this activity as 'Garlanding' (Figure 4).

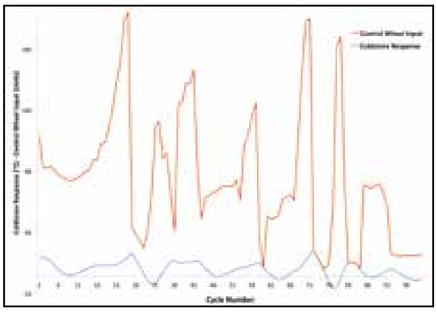


Figure 4: Garlanding

Other distinctive patterns emerged; one of them seemed to occur frequently and was always associated with a pilot subject. This approach could be called the "Tentative Pilot" strategy. The initial temperature recovery is largely dampened but then there is a slow and progressive trimming towards the final stable temperature, but from only one direction (usually downwards). What was notable about this tactic was that the subject frequently failed to complete the exercise in time (Figure 5).

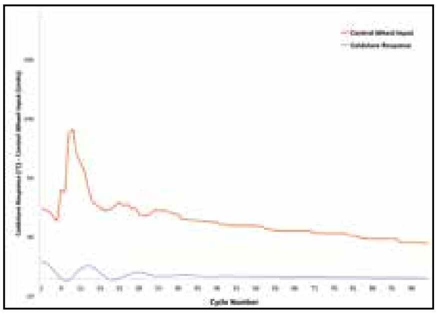


Figure 5: Tentative

Making Comparisons

Gathering the quantitative data and mapping correlations offered further insights. Figure 6 shows a plot of solve time versus subject age. The signal that emerged was unexpected. The negative correlation between age and solve time is statistically significant. The reason for this is speculative and further work would be required to make any definitive statement, however theories could be made involving compliance and conditioning. It may be worth noting that the green triangle data point was a result from a female Asian purser who out performed all but one of the pilots; the slowest were experienced line commanders, many of which are also CRM trainers.

Giving pilots a venue and experience to think problems through can only have a positive impact on operational safety.

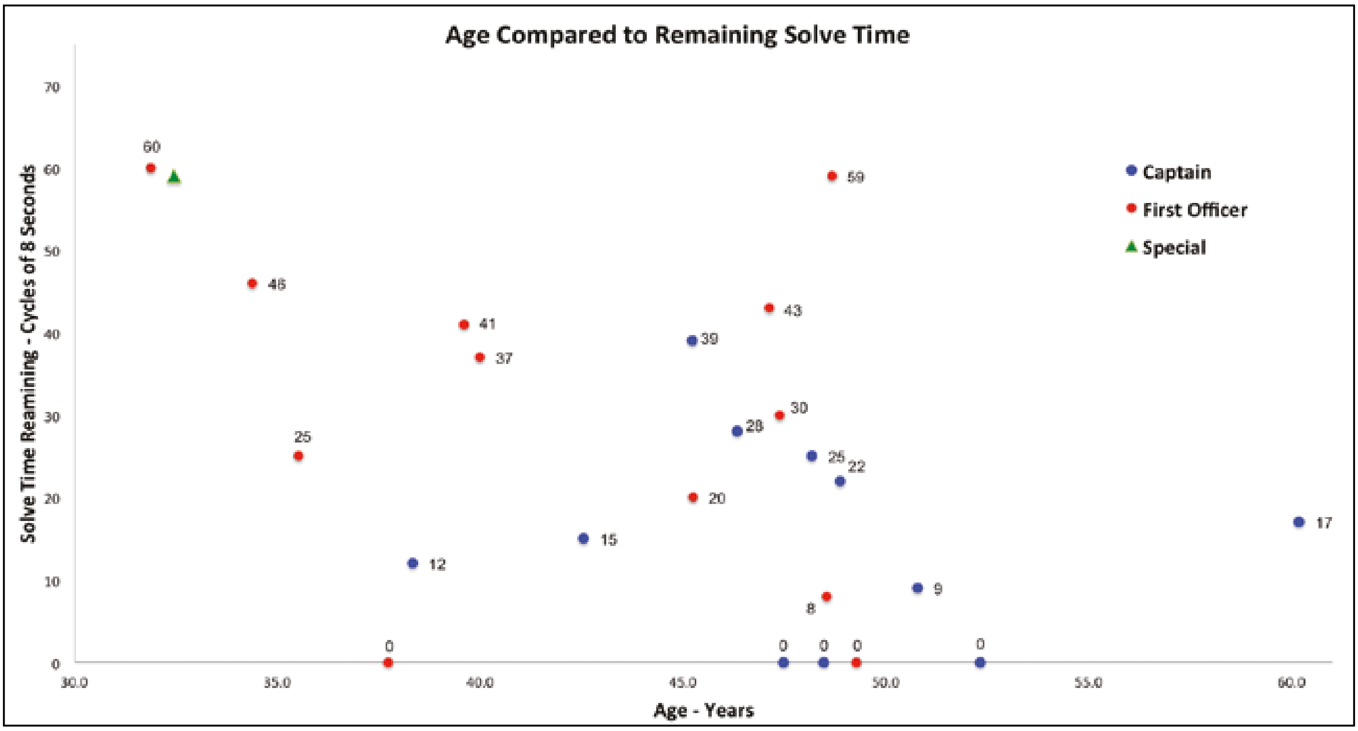


Figure 6: Graph of age versus solve time

Figure 1: "What's the problem?"

For someone with expertise, it is very simple to see that the white Top-Of-Descent arrow is somehow wrong. The aircraft is 141 nm from the VOR 'JDW' that is situated on the airfield and the Flight Management System is suggesting that the TOD will be in 40 nm. This would leave 100 nm to descent 40,000 ft. While this is possible to do with pilot intervention, it is less than desirable, especially with the slower traffic below (our aircraft is flying at M0.85). The high rates of descent that need to be achieved to recover the profile may have later implications.

The crew executed a Direct-To the Final Approach Fix for the approach they were going to fly, as cleared by Air Traffic. Somehow the Flight Management calculations became corrupted and miscomputed the TOD.

The real issue here is that there is only ONE data point amongst the other fifty-five data points that indicates another ONE data point is incorrect in a usually highly reliable system. This is part of the daily pilot experience, where only experience gives the pilot enough expertise to notice the discreet signaling that the system emits that either validates or disproves the mental construct the crew collectively possess about their current and future situation; thinking pilots will see the discrepancy.

Look How Far We've Come...

by Flight Safety Officer Zoe Reeves on the rise in helicopter automation within offshore operations, the issues and the future.

When I think of automation I think of fixed wing, I don't know why, perhaps it's because the helicopters I used to fly were so basic that having an artificial horizon indicator was pure luxury.

Fixed wing aircraft are much more stable than helicopters and thus lend themselves better to automation. Helicopters are unstable by nature. Maintaining the aircraft altitude requires constant inputs by the pilot on all of the controls (cyclic, collective and anti-torque pedals) generating a high workload. For this reason, autopilots for helicopters were rapidly taken up. Recently, autopilot functions have expanded to help the pilots to control not only the aircraft altitude but also its trajectory in three dimensions, and sometimes in four dimensions including time constraints.

In the wake of recent helicopter incidents, the safety of offshore helicopter operations has been comprehensively reviewed by the British Government, European regulators, manufacturers, operators and the oil and gas industry. Loss of control associated with the sophistication and automation of modern helicopters, the training that the pilot receives and the rise of commercial pressure have been identified as issues requiring attention.

How do we go about doing this you ask? We get together and discuss a different approach...

At a two-day conference presented by the Royal Aeronautical Society on 'Automation of offshore helicopters and the challenges the industry faces', it was discussed how to tackle the issues of complex automation in helicopters and how we best learn from the mistakes the airlines have made, and how we train our crews better to allow them to understand the technology they are using daily.

Below are some areas of improvement raised by leaders in the industry:

- Pilots need to reduce 'automation surprise' by being educated properly in the use of the automation
- Looking at the benefits of humancentric design within the cockpit
- The benefits of reducing the complexity of human-machine interface design (HMI). This is already happening with the use of touch screen devices but looking forward to colours, shapes and graphs to simplify complex operations
- Standardising across operators, standard operating procedures (SOPs) and learning from the airline industry's mistakes
- Understanding OEM (original equipment manufacturer) design philosophy, sharing lead customer experience, agreeing common procedures and incorporating these procedures for all training providers and mandating those philosophies
- Regulated training – generate training that meets basic safety, reflects role, environment and types but can also adapt to include global and local evidence
- The introduction of ATQP – alternative training and qualification programme
- Learning from the positive – EBT (evidence-based training).

At the end of the conference it was asked if the advent of digital avionics and complex automation in the modern helicopter cockpit changed the way we train. It was also asked: Does current training prepare a pilot for operational flying or is it a matter of ticking the regulatory boxes? The question we were all asked was: Could there be a better way to train? The consensus is that offshore helicopter training needs to offer a better platform for pilots to understand the greater automated design and procedures of the

modern helicopter. Perhaps a redesign of the cockpit layout with a greater focus on colours and graphical displays which display information more intuitively, SOPs that mirror the lessons learnt from the airline world, ATQP and EBT all have their role to play.

One fact remains however, commercial pressure and the fast declining resource of highly experienced military personnel are making it very difficult for the helicopter operators to recruit the right level of experienced pilots and keep it that way. This should not have a detrimental effect on safety but is the time and money there to train the pilots in a way the airlines do? A recent BALPA survey asked our helicopter pilot members whether they felt the outsourcing of training to aviation training organisations (ATOs) would lead to a rise in safety standards and 87 per cent said no. Perhaps we need to look at incorporating training back in-house again, which is easier said than done.

Automation is the way of the modern helicopter and the requirement to stay ahead of the drag curve is vital if we are going to reduce errors in the future.

If you have any comments or feedback please contact:
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Original article by Zoe Reeves published in BALPA's The Log Magazine Autumn 2014 edition.

Preventing Loss of Control in Flight

Boeing, as part of the Commercial Aviation Safety Team, recently completed a multiyear effort to analyze loss-of-control–in-flight events and generate feasible solutions in areas of training, operations, and airplane design. These safety enhancements have now been adopted by the Commercial Aviation Safety Team for implementation in the United States and are being advocated for worldwide adoption.

by Michael Snow, Ph.D., Associate Technical Fellow, Human Performance, Aviation Safety, and Randall J. Mumaw, Ph.D., Associate Technical Fellow, Human Factors, Flight Deck Design Center, Flight Crew Operations Integration

In the last decade, loss of control–in-flight (LOC-I) has become the leading cause of fatalities in commercial aviation worldwide. A subcategory, flight crew loss of airplane state awareness, has risen as a causal factor in these accidents.

This article explains safety enhancements that were recently adopted by the Commercial Aviation Safety Team (see "What is the Commercial Aviation Safety Team?" on page 19) and the process that drove the development of the enhancements. Implementation of the resulting training, operations, and airplane design safety enhancements is estimated to reduce the risk of future airplane state awareness events approximately 70 percent by 2018 and 80 percent by 2025.

A large, complex problem

Accident rates and fatalities in commercial aviation are at historic lows in recent years, even as air traffic has climbed. However, Boeing continues to work with industry and government partners to improve safety for the traveling public. In August 2010, the Commercial Aviation Safety Team chartered the Airplane State Awareness Joint Safety Analysis Team as a follow-on activity to previous work done by a LOC-I Joint Safety Analysis Team in 2000. The primary purpose of the Airplane State Awareness Joint Safety Analysis Team was to analyze a representative set of LOC-I accidents and incidents in which the flight crew lost awareness of the airplane's state, defined as:

Proposed loss-of-control–in-flight interventions cover a broad spectrum of potential solutions, including flight simulator training.

HOW MANY DO YOU REMEMBER?

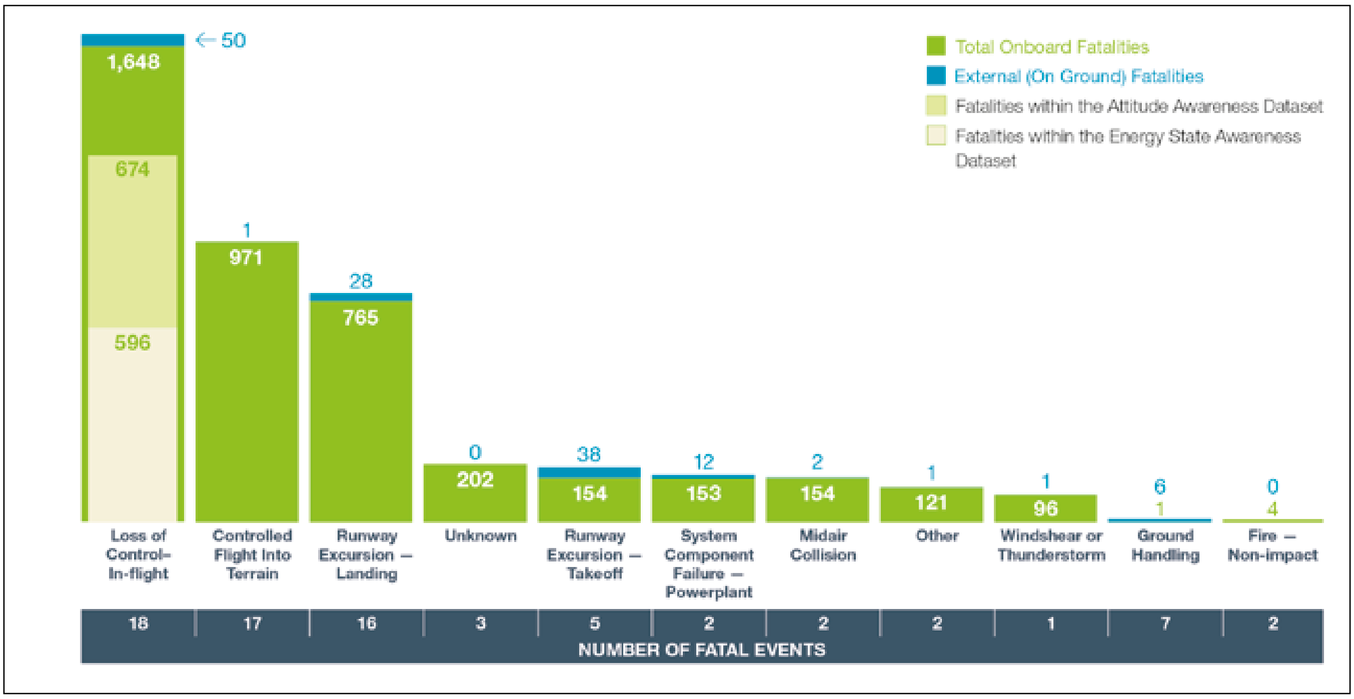

Figure 1: Worldwide jet transport fatal accidents, 2003–2012
The loss of airplane state awareness has been a major factor in worldwide jet transport fatal accidents during the last 10 years.

- Attitude (pitch or bank angle) or
- Energy (the combination of airspeed, altitude, vertical speed, thrust, and configuration control surfaces).

A review of worldwide transport airplane accidents during the period from 2003 to 2012 revealed that more than half of all LOC-I accidents and resulting fatalities involved flight crew loss of airplane state awareness (see fig. 1).

The Airplane State Awareness Joint Safety Analysis Team was co-chaired by Boeing and the U.S. Federal Aviation Administration and staffed with subject matter experts from major airplane manufacturers and suppliers, pilot unions, airlines, research organizations, data mining organizations, and government aviation safety departments and agencies. Two analysis teams studied 18 events, identified problems and major themes, and developed intervention strategies. A data team complemented the work of the analysis teams by assessing the presence, frequency, and characteristics of airplane state awareness precursors (conditions commonly leading to these events, such as stall warnings or extreme bank angles) in U.S. Part 121 operations, based on information available in the Aviation Safety Information Analysis and Sharing database.

Studying loss of control-in-flight

Nine of the events analyzed involved loss of attitude awareness and nine involved loss of energy awareness (see fig. 2). The objective of the analysis was to identify underlying problems that contributed to the accidents and incidents analyzed. In the course of this analysis, the teams identified 161 distinct problems, of which 117 were common with those identified by previous Joint Safety Analysis Teams and 44 were newly developed by the Airplane State Awareness Joint Safety Analysis Team. The analysis teams then identified a total of 274 intervention strategies to address these problems, of which 181 had been documented previously and 93 were newly developed.

Common themes among loss of control-in-flight

The Airplane State Awareness Joint Safety Analysis Team discovered 12 major themes that appeared across the events in the airplane state awareness dataset, which may be representative of common issues present in similar events (see fig. 3). Note that no single factor causes an accident or incident. In these events, it took a combination of at least six themes to result in a hazardous situation. The Airplane State Awareness Joint Safety Analysis Team did not assign a ranking to these themes and notes that higher frequency of occurrence (i.e., appearance in more events) should not necessarily imply greater importance.

- **Lack of external visual references.** In 17 of the 18 events, the event airplane was flying at night, in instrument meteorological conditions, or in a combination of night and instrument meteorological conditions, sometimes at high altitude or over dark land or water. As a result, the crew had to rely on instrumentation to establish and maintain orientation.
- **Flight crew impairment.** In seven of the 18 events, at least one member of the flight crew was affected by fatigue, illness, or alcohol consumption, and in some cases by a combination of factors.

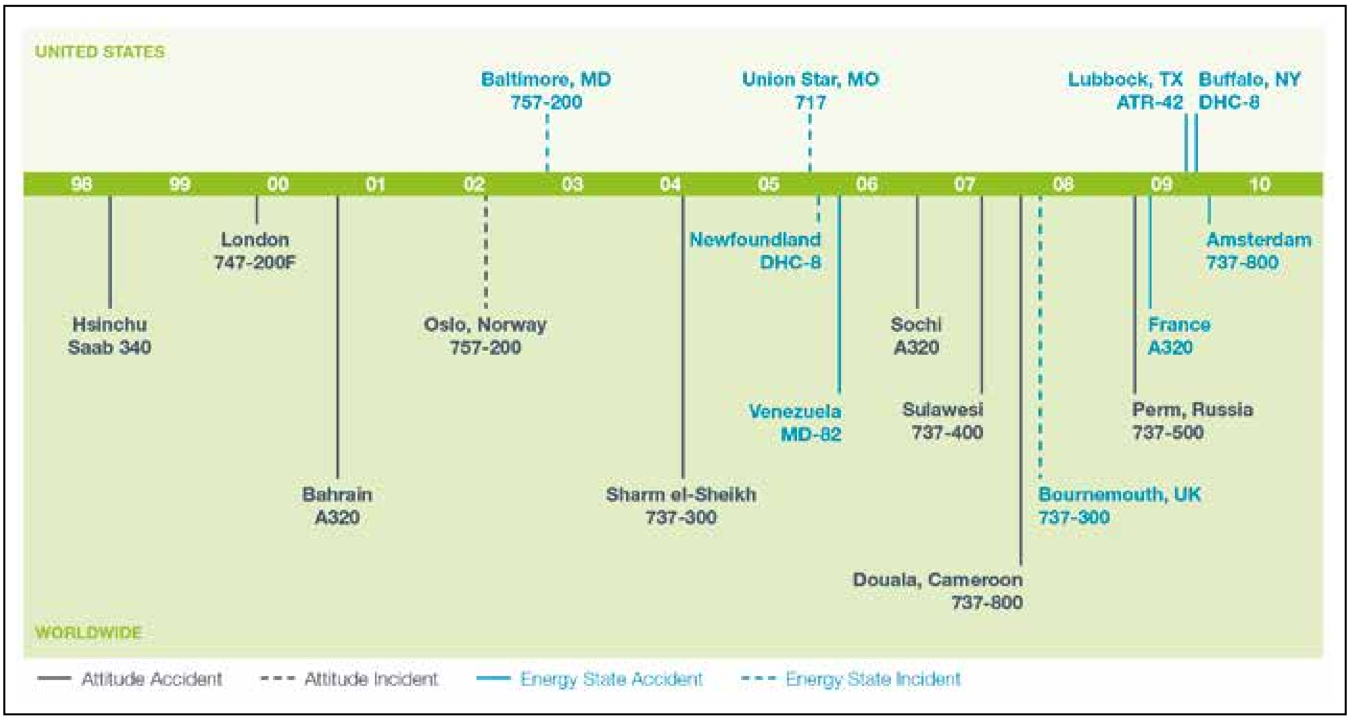

Figure 2: Airplane State Awareness Joint Safety Analysis Team event dataset
Of the 18 events studied by the Airplane State Awareness Joint Safety Analysis Team, nine involved loss of attitude awareness and nine involved loss of energy awareness.

- **Training.** In nine of the 18 events, flight crew training played a role. In some cases, the crew had not received training that is generally considered industry standard and is widely available. In other cases, the training had taken place but was not recalled properly or did not address the scenario encountered. In some instances, the Joint Safety Analysis Team considered the training that the crew had received counterproductive or negative.

- **Airplane maintenance.** Airplane maintenance was an issue in six of the 18 events. In some cases, maintenance was not performed in a timely manner, allowing problems to persist until they became factors in the accident chain. In other cases, maintenance was performed, but it did not directly address the actual problem or was performed on the wrong system.

- **Safety culture.** Safety culture played a role in 12 of the 18 events. In some cases, the operator had a poor safety record, extending back for months or years. Many of the flights operated with compromised safety, such as with less than fully functioning systems or with a poorly defined flight plan. In several events, the coordination and interaction with the air traffic management, both in flight planning and during the flight, was poor. Schedule pressure was prevalent, resulting in crews pressing on with flights or other activities despite warning signals that the situation was deteriorating. Crew pairing — particularly the pairing of pilots with low time in type — was also an issue (see the section on crew resource management).

- **Invalid source data.** In five of the 18 events, invalid source data from the air data system sensors or probes, inertial or rate gyro systems, angle-of-attack vanes or sensors, or other signals were used as input to primary flight displays, the autoflight system, or the navigation systems with little or no indication the data were invalid.

- **Distraction.** Distraction played a role in all 18 events and manifested itself in two ways.

	Lack of External Visual References	Flight Crew Impairment	Training	Airplane Maintenance	Safety Culture	Invalid Source Data	Distraction	Systems Knowledge	Crew Resource Management	Automation Confusion/ Awareness	Ineffective Alerting	Inappropriate Control Actions	Total
Formosa Airlines Saab 340	x	x			x		x	x	x		x		7
Korean Air 747-200F	x			x		x	x		x		x		6
Flash Airlines 737-300	x		x		x		x		x	x	x	x	8
Adam Air 737-400	x		x	x			x	x	x	x	x	x	9
Kenya Airways 737-800	x		x				x		x	x	x	x	7
Aeroflot-Nord 737-500	x	x	x	x	x		x	x	x	x	x	x	11
Gulf Air A320	x		x				x		x		x	x	6
Icelandair 757-200 (Oslo)	x						x		x	x	x	x	6
Armavia A320	x	x			x		x		x	x	x	x	8
Icelandair 757-200 (Baltimore)	x				x	x	x	x	x	x	x	x	9
Midwest Express 717	x				x	x	x		x		x	x	7
Colgan Air DHC-8-Q400	x	x	x		x		x	x	x	x	x	x	10
Provincial Airlines DHC-8	x		x				x			x	x	x	6
Thomsonfly 737-800	x		x	x	x		x			x	x		7
West Caribbean MD-82	x	x			x		x	x	x	x	x	x	9
XL Airways A320		x	x	x	x	x	x	x	x	x	x		10
Turkish Airlines 737-800	x			x	x	x	x		x	x	x		8
Empire Air ATR-42	x	x			x		x		x	x	x		7
Overall	17	7	9	6	12	5	18	7	16	14	18	12	

Figure 3: Summary of significant themes across all events

First, a flight crew would make a decision based on faulty information or incorrect reasoning (sometimes when task-saturated) and would be distracted by pursuit of actions or thought processes associated with that decision, a phenomenon known as confirmation bias. Second, the flight crew would become focused on one instrument or one response to the exclusion of all other relevant inputs, comments, or alerts and would essentially block out any information that may have led them to fully understand the problem they faced, a phenomenon known as channelized attention.

- **Systems knowledge.** In seven of the 18 events, the flight crew lacked understanding of how major airplane subsystems — such as autoflight, air data measurement, navigation, and inertial systems — interact and how information from one system influences another.

- **Crew resource management.** In 16 of the 18 events, crew resource management was not practiced effectively. Specifically, flight crews failed to communicate effectively or work together to understand and resolve problems or confusion. In a number of events, the pilot monitoring failed to properly perform the monitoring function.Crews also failed in some instances to manage their workload properly. In a few events, an authority gradient between the captain and first officer likely played a role in preventing the first officer from taking control of the airplane from the captain, even when the captain was clearly failing to correct a hazardous airplane state.

- **Automation confusion/awareness.** In 14 of the 18 events, the flight crew was either confused about the state (i.e., on/off) or mode of the autoflight system or else was unaware of trim or control inputs made by the autoflight system.

- **Ineffective alerting.** In all 18 events, alerting was an issue. The intended function of a flight deck alert is not simply to go off: rather, it is to raise flight crew awareness to a potential hazard, assist the crew in understanding the hazard, and (where possible) provide guidance to avoid or recover from the hazard. The term "ineffective" in this context is meant to convey only that the alert, if present, failed to impact flight crew awareness, understanding, and behavior in the manner intended. It is important to note that alerting effectiveness is not solely the result of airplane design: it is also significantly affected by flight crew training, communication, attention, and other factors in the flight deck environment.

- **Inappropriate control inputs.** In 12 of the 18 events, the flight crew responded to hazardous airplane states and conditions with control inputs that were opposite to what was necessary to recover the airplane. The term "inappropriate" is intended to convey only that the control inputs were not correct for the purpose of recovering the airplane and should not be construed to automatically imply pilot error.

Preventing loss of control-in-flight

Hundreds of intervention strategies were identified by the Airplane State Awareness Joint Safety Analysis Team to mitigate the problems observed in the 18 Airplane State Awareness Joint Safety Analysis Team events, and they were grouped into categories, based on how, and by whom, they

What is the Commercial Aviation Safety Team?

The Commercial Aviation Safety Team is a voluntary collaboration between U.S. government and industry that was founded in 1998. Its goal is to reduce fatality risk 50 percent in airline operations by 2025. It operates by consensus, deciding as a group which problems represent the greatest threats to aviation safety, chartering teams (e.g., Joint Safety Analysis Teams) to analyze those problems and underlying issues, determining feasibility of potential solutions (via Joint Safety Implementation Teams), and then tracking the implementation and effectiveness of adopted solutions (i.e., safety enhancements).

would be implemented. These categories include airplane design, flight crew training, maintenance, and safety data and research.

Airplane design. These interventions called for action on the part of airplane manufacturers or suppliers related to the design of current and future airplanes. The highest-rated interventions related to airplane design fell into these general areas:

- Flight envelope protection.
- Improved alerting.
- Flight path/control guidance on displays.
- Source data integrity.
- "Day-visual meteorological conditions" display systems.
- Automation design.
- Energy management display/ prediction systems.

Flight crew training. These interventions called for updates to current flight crew training curricula, standards, additional training, and improvements to flight simulator fidelity. The highest-rated interventions related to flight crew training fell into these general areas:

- Revised approach-to-stall training.
- Expanded upset prevention and recovery training.
  - Scenario-based situations.
  - Stall recognition and recovery.
  - Spatial disorientation recognition and recovery.
- Reemphasized/expanded crew resource management.
- Flight crew proficiency.
- Flight simulator fidelity.

Airline operations and maintenance. These interventions called for action on the part of operators or air traffic management to improve and expand operating policies or procedures. The interventions related to airline operations, including air traffic control issues and airplane maintenance, fell into these general areas:

- Maintenance procedures.
- Flight crew qualifications.
- Nonstandard flight operations.
- Reemphasis and rationale for standard operating procedures.
- Flight crew impairment.
- Safety culture.

Safety data. These interventions called for expanded data mining and sharing programs and safety management principles. The interventions related to safety data fell into these general areas:

- Sharing of safety-related data (e.g., the Aviation Safety Information Analysis and Sharing Program).
- Operator safety management systems.
- Sharing of service difficulty reports.

Research. Research interventions based on the Joint Safety Analysis Team process do not receive an overall effectiveness score. Ranking of research interventions for priority was based on which research interventions addressed the highest number of high-scoring problems. The top research interventions, based on this methodology, fell into these general areas:

- Spatial disorientation.
  - Displays to prevent spatial disorientation.
  - Alerting of spatial disorientation conditions.
- Maintaining flight crew awareness in high-workload environments.
- Automatic systems for error detection, prevention, and recovery.
- Human performance benefits of poststall recovery training using advanced flight simulator aerodynamic models.

Developing safety enhancements

After the Airplane State Awareness Joint Safety Awareness Team identified intervention strategies, the Commercial Aviation Safety Team chartered the Airplane State Awareness Joint Safety Implementation Team to review them; assess them for technical, financial, operational, schedule, regulatory, and social feasibility; and develop new safety enhancements. The team then developed detailed implementation plans based on the approved safety enhancement

HOW MANY DO YOU REMEMBER?

concepts. The proposed training and operations safety enhancements focus primarily on:

- Revisions and improvements to existing flight crew training in upset prevention and recovery, including revised approach-to-stall training.
- Revisions to go-around training.
- Policies and training for prioritizing controlled flight in non-normal situations.
- Training verification and validation.
- Enhancement of crew resource management training to further define and practice the duties of the pilot monitoring.
- Monitoring and understanding of habitual noncompliance to standard operating procedures and improvements to standard operating procedures.
- Policies for conducting nonstandard, nonrevenue flights.

In addition to training and operations safety enhancements, the team generated three airplane design safety enhancements that the Commercial Aviation Safety Team has adopted and that Boeing and other Commercial Aviation Safety Team–represented airplane manufacturers have committed to implementing on their next all-new type designs:

- **Flight envelope protection.** This safety enhancement has already been implemented by Boeing on its latest fly-by-wire commercial airplanes, the 777 and the 787.

- **Bank angle alerting with recovery guidance.** Boeing is now working to implement this safety enhancement in the 737 MAX and the Next-Generation 737 (see fig. 4).

- **Virtual day-visual meteorological conditions displays.** Boeing's commitment is contingent on successful completion of relevant research and development and supporting industry standards. Boeing recently demonstrated these displays, also referred to as synthetic vision systems, in the 787 EcoDemonstrator. Because these displays are effective at supporting flight crew attitude awareness, Boeing continues to engage with government and industry partners in research and development to bring these systems to application readiness.

"Roll Right!"

Figure 4: Bank angle alerting with recovery guidance

Boeing is implementing auditory and visual bank angle alerting with recovery guidance in the 737 MAX and the Next-Generation 737.

The airplane state awareness safety enhancements are integrated into a coordinated safety plan with a goal of balancing short-term tactical mitigations provided by operational and training programs with longer term, more strategic solutions resulting from improved design.

The airplane state awareness safety enhancement portfolio was constructed by the Airplane State Awareness Joint Safety Implementation Team to provide both near- and far-term solutions that reinforce each other and provide a balanced, redundant approach to addressing the issue of flight crew loss of airplane state awareness. Like the underlying problem being solved, the solution set is complex and addresses multiple issues. The analysis estimates that implementation of the training, operations, and airplane design safety enhancements would reduce the risk of future airplane state awareness events approximately 70 percent by 2018 and 80 percent by 2025.

The Airplane State Awareness Joint Safety Implementation Team recommended adoption by all U.S. Commercial Aviation Safety Team members of the training, operations, and design safety enhancements, and it recommends these enhancements be communicated to international aviation safety communities for their review and implementation where applicable. The Commercial Aviation Safety Team and its members have now officially adopted and published these safety enhancements as part of the Commercial Aviation Safety Team Safety Enhancement Plan and are working with the International Civil Aviation Organization and the international safety community to increase adoption worldwide. The plan can be found at http://www.skybrary.aero/index.php/Portal:CAST_SE_Plan.

Summary

Loss of airplane state awareness plays a significant role in at least half of all LOC-I category events.

An industry analysis of a representative set of events identified specific problems and major themes and resulted in proposed interventions that cover a broad spectrum of potential solutions in the areas of airplane design, flight crew training, airline operations and maintenance, and safety data.

The Commercial Aviation Safety Team has now officially adopted the resulting safety enhancements and is working to implement them in the United States and worldwide.

Credit: Copyright, Boeing.

Aircraft encounters with weather balloons: risks and mitigations

by R W Lunnon: Royal Meteorological Society

1. Background

There have been a number of incidents stemming from aircraft encounters with airborne objects similar to balloons, where the pitot systems on the aircraft have been affected. As far as is known, none of these encounters have been with radiosonde balloons, and it is not clear, given that a radiosonde balloon is designed to burst, that such a balloon poses a threat to the pitot system and other measurement systems on aircraft. This study considers the threat from radiosonde balloons and mitigations: one of the mitigations applies to all balloons and other causes of problems with pitot systems (although this mitigation can be considered to be a stand alone topic).

2. Current use of radiosondes in the British Isles and elsewhere

Radiosonde stations in the British Isles fall into 3 categories. Reference stations (Camborne, Lerwick, Valentia) release radiosondes twice daily, at 2315 GMT and 1115 GMT. Automatic stations (Herstmonceux, Watnall, Albermarle and Castor Bay) release radiosondes daily, at 2315 GMT. MOD stations (Larkhill, Aberporth and South Uist) release radiosondes as/when needed to support trials (e.g. artillery at Larkhill). Thus there are no regular releases of radiosondes along the SSE/NNW axis of Britain except at night when domestic passenger flights are minimal.

Information on the web, for example, http://badc.nerc.ac.uk/data/radiosglobe/europe.html (which as advertised in an FSB article on In Flight Impacts) imply that there are 30 launch sites in the UK, whereas in fact there are 9 as described above. That web link states that there are 200 sites across Europe: this figure is almost certainly too high.

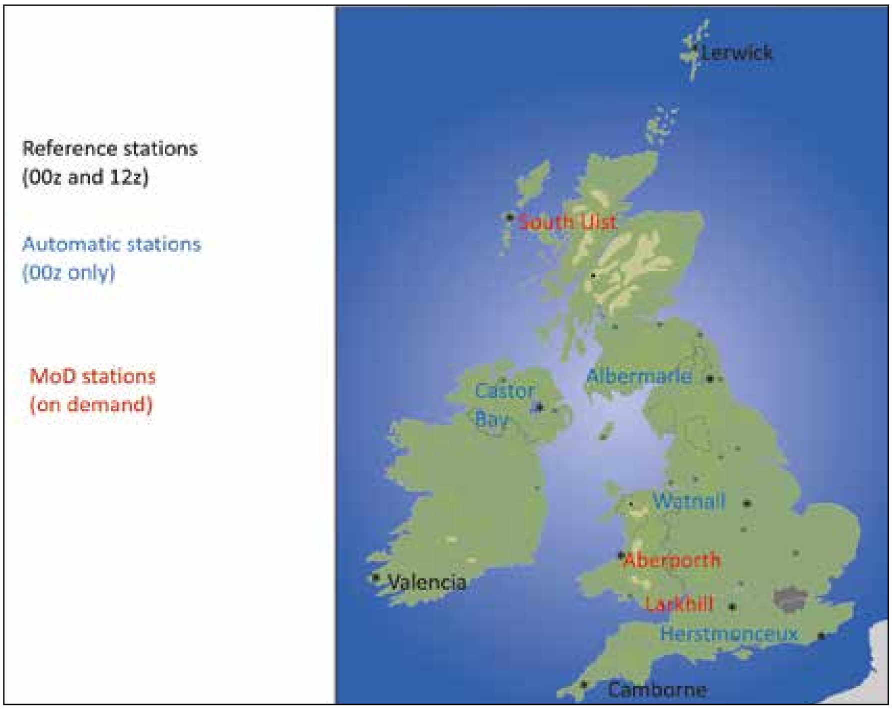

Figure 1. Shows current Met Office Radiosonde launch sites

The nominal ascent rate of radiosonde balloons is 1000 feet/minute (between 5 and 5.5 m/s). This figure can be used to quantify the risk of an encounter at a particular time at a particular flight level.

Use of radiosondes in other parts of the world follows a similar pattern to that in the British Isles. Radiosondes are rather expensive and it is much more cost effective to obtain wind, temperature and is possible humidity information from commercial transport aircraft. Therefore the use of radiosondes in areas where there is dense commercial air traffic will tend to be avoided at the times of day when air traffic density is at its highest.

2.1 Movement of small balloon in proximity of an aircraft

It is noted that while there have been a number of "near misses" between weather balloons and aircraft, there have been no reports of collisions. It is of importance to understand why this might be. Immediately ahead of an aircraft in flight there is a "nose" of air where the pressure is higher than would otherwise be the case. This nose serves to deflect the air well ahead of the aircraft round the fuselage of the aircraft. Figure 2 shows the trajectories of (a) air (in blue), (b) a hypothetical heavier than air object (such as a UAV) (in red) and (c) a hypothetical lighter than air object (such as a small helium

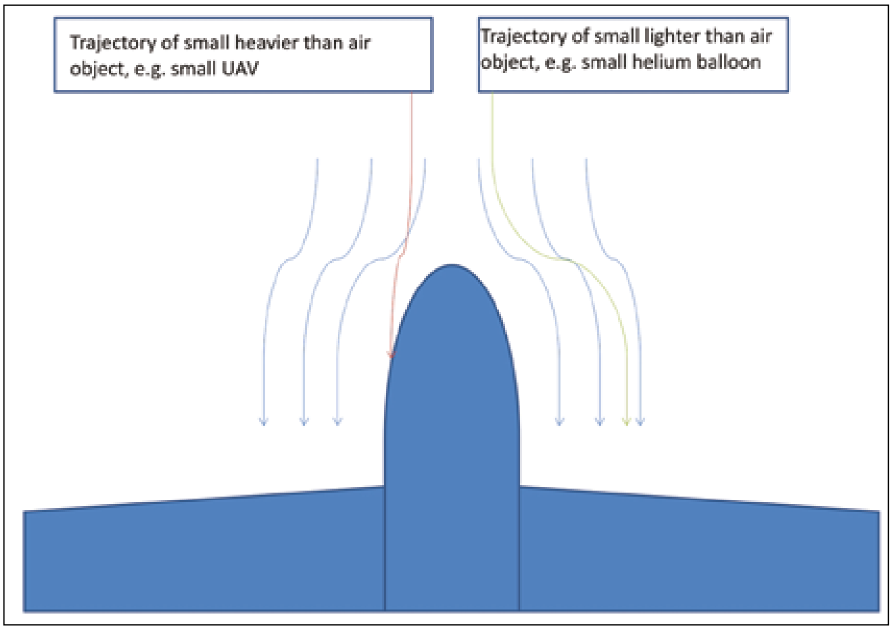

Figure 2. Shows aircraft wings and fuselage (lower part of figure) together with trajectories (relative to the aircraft) of various objects which the aircraft is approaching. The blue lines indicate trajectories of the free air, the red line indicates the trajectory of a small heavier than air object, and the green line indicates the trajectory of a small lighter than air object.

balloon) (in green). As can be seen the lighter than air object swerves well out of the way of the aircraft, whereas the heavier than air object follows a trajectory which is much straighter than that of the air, and the probability of a heavier than air object hitting a sensor such as a pitot system would be relatively high. The figure does not tell us much about a large lighter than air object, such as a balloon at, say, 35000 feet, but it is clear that such an object would distort and divert so that the probability of a collision would be much lower than observations of such an object from the cockpit of an approaching aircraft would suggest. Note that the combination of a helium balloon and radiosonde instrumentation is significantly lighter than air: at aircraft cruising altitudes the combination is still ascending at approximately 5m/s which would not be possible if the combination had the same overall density as air.

3. Mitigation 1 – prediction of position of radiosondes

Radiosondes are released from well defined points at predictable times. Assuming they are filled with a pre-set quantity of helium, their ascent rate is predictable. Therefore the trajectory (in 4 dimensions) of the radiosonde is largely predictable – it depends on the wind at levels from the surface to the level of interest. In principle an airline with access to forecast winds generated by the Met Office could predict the trajectory of any radiosonde anywhere in the world.

The involvement of Air Traffic Management service providers in the provision of predictions of radiosonde predictions is recommended. One possible scenario is that individual Met Services who release radiosondes provide predictions of their positions to ATM providers controlling the airspace through which the radiosondes are expected to pass (this would take into account the three-dimensional structure of airspace). The ATM providers would then vector aircraft round any radiosondes in their airspace. The use of new software such as a dedicated App would be very helpful in implementing this mitigation.

4. Mitigation 2 – diagnosis of position of radiosondes

Radiosondes routinely broadcast their position (along with other met data such as temperature) and do so in one of only two frequencies – 403Mhz or 1680MHz. There is nothing in principle to prevent a suitably equipped aircraft "listening in" to the transmissions of any radiosondes within radio range. The position information could then be fed into a system such as TCAS which could then provide advisories (and other warnings) to the pilot recommending changes of flight path which would enable the aircraft to avoid the radiosonde. It is noted however that there are considerable cost implications in equipping aircraft to receive these frequencies.

When this material was presented (at SIE meeting in January 2015) it was suggested that radiosondes could be fitted with transponders so that TCAS systems could interrogate them. It is understood that fitting radiosondes with transponders is not technically very difficult. However it would require ICAO to make an approach to the World Meteorological Organisation (WMO). The transponder approach is the solution preferred by some in the aviation community.

5. Mitigation 3 – reduced reliance on pitot tube information

As mentioned in the introduction, this mitigation can be seen as something of a standalone topic compared to the previous mitigations but is included in this paper for completeness. It is helpful to bear in mind that the most important issue is to recognise when pitot systems are not performing nominally and thereafter the emphasis should surely be on immediate achievement of safe flight.

Radiosonde balloons, and other similar objects, pose a threat because of the risk of affecting the determination of airspeed using pitot systems on aircraft.

5.1 Other threats to measurements by Pitot systems

A number of mechanisms can affect the performance of Pitot systems. These include

(a) Icing, as affected flight AF447 (although note that icing can be a temporary problem as in the case of AF447, and that the solution can be simply to carry on flying more or less as before)

(b) Volcanic ash

(c) Bird strikes

(d) Foreign objects

(e) Balloons and other airborne objects made of rubber, e.g. banners

If a mitigation can be developed which works through reducing dependency on pitot systems, then this can be applied to the other causes of pitot unreliability.

5.2 Accuracy of components of the "wind triangle"

In the absence of any of the effects (a) to (e) above, airspeed has a typical RMS error of ~1m/s. The accuracy of the ground velocity vector is also very good, using a combination of Inertial Reference Systems (IRS) and Satellite Navigation Systems (typically GPS) giving a typical RMS error in either of the components of the vector of ~1m/s. Aircraft heading is a significant source of error in determining the wind vector as derived from airspeed and ground velocity, and this has a typical RMS error in either of the components of ~1.5m/s.

5.3 Accuracy of upper level wind forecasts

Upper level winds are the most accurate forecasts the Met Office produces (compared to natural variability) and RMS errors have approximately halved in the last 20 years. Statistics on accuracy are available on the Met Office website. Currently 24 hour forecast winds at FL390 have a RMS vector error of 3m/s for the zone north of 20oN. This figure applies to average wind over 10-20km: for shorter distances there will be larger errors. Shorter range forecasts have smaller errors. The 3 m/s figure is for vector error: for a single component the RMS error will be 3/√2 which is approximately 2m/s.

It is clear that in the absence of any of the effects (a) to (e) above, airspeed is more accurately determined from the pitot system. However, in the presence or suspicion of any of the effects (a) to (e) above, use of forecast wind data coupled with ground velocity information from on-board sources can significantly reduce uncertainty. For example, if the two pitot systems give different figures for airspeed, in many cases it should be possible to decide which of the two systems is more accurate using forecast wind information. This was a noted aspect of flight AF447. For the period between 2:10:04 and 2:10:26 the two computed airspeeds were significantly different 40% of the time; for the period between 2:10:26 and 2:10:50 the two computed airspeeds were significantly different 70% of the time; for the period between 2:10:50 and 2:11:46 the two computed airspeeds were significantly different 30% of the time. (See figures 26 to 28 of the BEA final report).

5.4 Indicated airspeed and true airspeed

In most contexts the critical quantity that a pilot will refer to is indicated airspeed rather than true airspeed. In order to convert between the two it is necessary to make reference to outside air temperature and barometric pressure. Although it does not follow that if the pitot system was not performing nominally anomalous measurements would be made by the air temperature sensor and/or the static pressure sensor, it is certainly true that air temperature sensors are prone to icing problems and foreign objects could affect any sensor. However forecast information is available on both temperature and the geometric height of flight levels. Temperatures have a RMS error of 0.7 degrees which would give rise to a true airspeed error of less than 1m/s. The forecast true heights of flight levels are also broadcast as part of the services provided by World Area Forecast Centres. It is possible to combine the forecast heights with the geometric aircraft height derived either from the IRS or GPS to derive the flight level of the aircraft without reference to the static pressure. It follows that if all relevant forecast information was available on the flight deck, an aircraft could fly without pitot systems, outside air temperature sensors or static pressure sensors.

5.5 Practical use of forecast wind, temperature and geometric height information

If there was a sudden malfunction of the pitot system giving rise to anomalous airspeed readings, it is unlikely that a pilot who had never made use of forecast wind information on the flight deck would be able to solve wind triangles

HOW MANY DO YOU REMEMBER?

and derive the aircraft's true airspeed. Therefore it is recommended that pilots practise accessing the required data and performing the requisite calculations in order to fly the aircraft safely. In an era of highly automated aircraft, a significant role for the pilot is understanding anomalous indications and taking appropriate action – "debugging the aircraft". This is made much easier if the pilot has a good appreciation of plausible values of relevant parameters – in this case the sides of the wind triangle, and if necessary, both indicated and true airspeed and the relationship between geometric height and Flight Level along the expected trajectory of the aircraft. Clearly there is a role for Electronic Flight Bags here, enabling some of the more challenging calculations to be performed and providing plausible limits for unfamiliar parameters.

Note that applying some common sense rules about Power/Attitude and altitude could be as effective as application of the wind triangle.

5.6 Altitude considerations when flying with imperfect airspeed information

Generally speaking at a specific gross weight and altitude, there is a range of airspeeds at which an aircraft can safely fly. If the pitot system is performing nominally, an aircraft can fly safely close to the ceiling altitude appropriate to the current gross weight. In the event of using forecast wind vector information to determine airspeed, it is probable that an aircraft should fly at a lower altitude so that the actual airspeed flown by the aircraft lies within safe limits even though there are errors in the diagnosed airspeed arising from the use of the forecast wind. The calculations performed by the pilot in "practice mode" as described in the previous section should include consideration of any altitude changes required in the event of pitot malfunction.

5.7 Specific recommendations on the use of forecast data

If errors are to be kept to a minimum, it is essential to use the scientifically correct approach to utilising the forecast data. In general upper air forecast data are provided on a 4-dimensional grid and it is necessary to apply 4-dimensional interpolation to obtain the correct forecast value at the current position and time of the aircraft. Data used in flight plan calculations often assume a specific take-off time and a specific trajectory in 4 dimensions. Therefore if wind data are only available for the flight planned route, these may well be inadequate in the event of a pitot malfunction if the aircraft has departed from the planned route in any way. Therefore it is essential to have available on the flight deck wind information for a range of latitudes, longitudes, altitudes and times covering both the expected route and a range of plausible reroutes.

5.8 Training for pilots on flight with unreliable airspeed indication

There is considerable reference to this in the report on the accident to AF 447. In particular there are three appendices:

Appendix 5: Air France "Vol avec IAS douteuse" procedure

Appendix 6: Airbus "Unreliable speed indication" procedure

Appendix 7: Extracts from Air France briefing brochure ("IAS douteuse" exercise)

It was noted that all three pilots had undertaken simulator training on IAS douteuse. However, the pilots apparently did not apply common sense rules about Power/Attitude and altitude, as recommended earlier.

5.9 Comment on necessity for good measurements of airspeed

Current accuracy of forecasts of upper level winds from the Met Office depends critically on the availability of accurate measurements of wind vector, particularly automated reports from aircraft. These in turn depend critically on accurate airspeed measurements.

5.10 Appendix 1: statistics

Earlier a RMS vector error of 3 m/s was quoted. In this section data are provided which make it easier to interpret this statistic. In general, errors in forecast wind components satisfy a normal distribution. This enables us to quantify the risk (probability) of a wind component with an error exceeding a specified threshold. Specifically we can say that the probability of a wind error exceeding three standard deviations (6.3 m/s) is 0.001. Clearly lower probabilities apply to larger errors. The probability of an error in excess of 50 knots is less than 10^{-12}.

6. Appendix 2 – extension of mitigation 3 to Angle of Attack sensor problems

The following comments are provided in the context of an incident to a Lufthansa A321 near Bilbao on 5/11//2014. In the incident both AoA sensors experienced icing and both transmitted incorrect, but very similar, values to the on-board computers. As a result flying the aircraft was made very difficult and a 4000 foot loss of altitude was experienced.

AoA sensors when operating nominally measure the direction of flow of air relative to the fuselage (in the relevant plane). If it were possible to predict the vertical motion of the atmosphere and it was possible to determine the pitch angle of the aircraft (in addition to all the quantities needed to determine airspeed) then it would be possible to diagnose AoA from that information. The Met Office (and other meteorological centres) predicts the vertical motion of the atmosphere. However, the predictions do not form part of the service provided as a World Area Forecast Centre for aviation. Additionally, as there are no routine measurements of vertical motion of the atmosphere there is uncertainty as to how accurate these predictions are.

Acknowledgement

This paper has been improved as a result of review by Alex Fisher.

The Dryden Accident – A Driver for Chance

by Dai Whittingham, Chief Executive UKFSC

On 10 March 1989, C-FONF, a Fokker F28-1000 Fellowship operated by Air Ontario took off from Dryden Municipal Airport, an intermediate stop on its journey from Thunder Bay to Winnipeg. The aircraft crashed after only 15 seconds of flight. Of the 65 passengers and 4 crew, 44 passengers and one flight attendant survived; the FDR and CVR data were destroyed in the post-impact fire. The subsequent investigation uncovered a catalogue of human error, organisational and regulatory shortcomings, and generated 191 recommendations, many of which were addressed to the operator and Transport Canada.

The investigation was unusual in that it was conducted by a judicial commission led by the Hon Virgil Moshansky, a Justice in the Alberta courts. Judge Moshansky had specialist accident investigators as part of his team, but his inquiry also considered the role of Air Ontario and Transport Canada in some detail. Pertinent to the current debate about release or otherwise of the Sumburgh accident FDR and CVR data, Moshansky was also faced with questions about disclosure of confidential safety and other data in support of his investigation; he determined that the public interest demanded the release of information for accident investigation purposes even if it had been provided in confidence for safety and accident prevention work. Unusually for an air accident investigation, and perhaps driven by the different nature of judicial inquiries, Moshansky's report includes the names and positions of all those involved in the accident and every witness who gave evidence to the inquiry commission. The inquiry also acted as an inquest on behalf of the Coroner's Office.

The facts

Air Ontario had been formed 2 years earlier from a merger between 2 other operators, one running a commuter operation in southern Canada and the other effectively a bush operation in the northern parts. The northern routes had been sold off to another entity but a commercial arrangement remained for scheduling purposes. Air Ontario was operating essentially as a feeder for Air Canada's national network. The F28 captain was a product of the commuter operation but his experience was mainly piston/turbo, though he had also flown the Gulfstream II. The first officer was from the northern operator and his experience was also mainly piston/turbo, albeit with some Cessna Citation time. The F28 was the largest jet aircraft either had flown in commercial service and, at the time of the accident, their combined experience on type was less than 150 hours. The lack of type experience was the subject of 2 recommendations to Transport Canada.

Air Ontario Flight 1362/1363 was scheduled to fly a return Winnipeg to Thunder Bay, with intermediate stops at Dryden. The same crew were then to operate as Air Ontario Flight 1364/1365, a Winnipeg - Thunder Bay return with no intermediate stop, a duty day of less than 10 hours. Moshansky reports that "The area weather forecasts for the day's operations showed generally unsettled and deteriorating weather, including lowering cloud ceilings and freezing precipitation as the day progressed. Terminal weather forecasts for Thunder Bay and Winnipeg were available to the crew before their departure. These forecasts indicated conditions that could potentially deteriorate to below the captain's landing limits at their scheduled arrival times." Fuel requirements for the alternate and an upload of 10 passengers meant that, most unusually, refuelling at Dryden would be required.

When the crew checked in at Winnipeg, they discovered that their aircraft had no APU; the equipment had been malfunctioning for the previous week and rectification work had proved unsuccessful. A management decision had been taken the previous day deferring the defect until the aircraft returned to Toronto later on the night of the accident. Unfortunately, Dryden lacked the GSE needed for a ground start, which meant the crew would need to keep an engine running throughout the refuelling process. As a further consequence of the decision the aircraft could not be legitimately de-iced at Dryden because a proscription had been published in both a Fokker aircraft winter operations bulletin and an Air Ontario operational directive against de-icing the F-28 aircraft with one or both engine(s) running. Although icing conditions could be expected, the captain did not ask for a waiver to allow C-FONF to be de-iced. However, the captain did require the aircraft to be de-iced before departing Winnipeg. The weather at Dryden was within the captain's limits for the first leg but at that stage Thunder Bay was unsuitable.

HOW MANY DO YOU REMEMBER?

Commercial pressure

The first leg was unremarkable, though an engine remained running throughout the time on the ground at Dryden. The second leg to Thunder Bay went ahead after a short delay on the basis of an improving forecast which subsequently proved to be correct, arriving 20 minutes late. After refuelling at Thunder Bay the captain was informed that he would be carrying an extra 10 passengers and that the flight was therefore overweight. He decided to offload the additional passengers but was over-ruled by the duty manager, who decided that the weight would be adjusted by defuelling, imposing a further 35 minute delay. At this stage the crew were coming under pressure from passengers concerned about their connecting flights. There was evidence given at the inquiry to suggest that the various phone calls in connection with the additional passengers and the overweight situation had left the captain angry and frustrated; there had been a noticeable change in his demeanour during the Thunder Bay stop.

The flight release for the return leg to Dryden anticipated an engine-running refuel (hot refuel). There had also been a new TAF issued for Dryden which forecast freezing precipitation, whereas the previous forecast had not; it is not known whether the crew read the revised forecast, though it was certainly available to them. The aircraft arrived at Dryden about 1 hour behind schedule. On approach in VMC, the runways were reported as being bare and dry, though light snow grains had been observed to the west. It began to snow lightly soon after the aircraft touched down. During the 30 minutes the aircraft was on the ground at Dryden conditions deteriorated significantly; 21 minutes prior to its last take-off the actual report was "Sky partially obscured, estimated ceiling 4000 feet overcast, visibility 2½ miles in light snow, wind 260"T at 3 knots" whereas only 18 minutes later the conditions were: "Precipitation ceiling 300 feet, sky obscured, visibility 3/8 mile in snow, wind 170" at 4 knots." The weather reports for Thunder Bay and the alternate also included freezing rain throughout the period, and the investigation concluded both the operations control system and the crew should have been aware of the potential exposure to airframe icing on the ground.

The hot refuelling was conducted by personnel inexperienced with the F28 and with passengers still embarked; moreover, the fuel was Jet-B which is flammable at +1C. This practice was condemned as unsafe by Moshansky and his early recommendation for a prohibition was immediately accepted by Transport Canada. There were also recommendations relating to training for refuelling personnel.

Pre-take off

The captain initially remained on the aircraft during the refuel before heading to the terminal to call the ops controller. He was seen to walk quickly back to the aircraft but it was observed by one survivor that he "rather looked disgusted ... just not a happy expression". Neither of the pilots was seen carrying out a walk-round inspection of the aircraft. Before the aircraft taxied it was snowing quite heavily and its movement was delayed briefly by the arrival of a C172 on a recreational flight, the pilot reporting that he was having severe difficulties in the snow. Radio transmissions from the aircraft further reflected frustration on the part of the captain. At this stage the snow was reported to the investigators by the Cessna pilot as being 'heavy and wet'. The first officer, responding to the instruction to hold position, acknowledged but advised that vis was "down to half a mile in snow". The Cessna pilot also observed that the first portion of the runway was contaminated with around half an inch of slush.

A number of passengers later reported seeing snow and ice on the F28 wings prior to take-off, including 2 off-duty pilots, one a captain with Air Canada and the other a captain from another fleet within Air Ontario. Both described ¼ to ½ inch of snow on the wings, one describing the snowflakes melting and adhering to the wing surface. Both presumed the captain would have the aircraft de-iced before take-off and neither brought their concerns to the attention of a crew member. However, the surviving flight attendant also noticed the snow and said nothing. This was also the subject of a recommendation, namely that captains should have a duty to check, or have checked, wing surface conditions in the event of a report from a crew member; this also implies that crew members should have an understanding of the dangers of ice and snow contamination and this was duly recommended as a matter of urgency in the interim report.

The take-off

As the aircraft began its take-off roll it was snowing heavily. The off-duty Air Ontario pilot recalled seeing about 10-20% of the snow blowing off the surface as the aircraft gathered speed, with the rest changing colour and texture. The other pilot recalled seeing the snow crystallising into ice and observing about half an inch of slush on the runway. Witnesses on the ground reported the aircraft as being slow to accelerate but it lifted off near the 5700ft point of the 6000ft runway. The initial rotation produced buffet (observed by the Air Canada pilot) and the attitude was reduced before a second rotation; it is probable that the aircraft was airborne briefly after the first rotation but settled back onto the runway. C-FONF gained very little altitude, and some minor roll excursions were seen before it hit trees and crashed 3000ft beyond the end of the runway.

The aftermath

The Dryden Crash Rescue and Fire (CRF) service responded but one of the vehicles was being refilled having been used to wash down a small fuel spill that occurred during the hot refuelling of C-FONF. When the initial personnel arrived near the crash site a few minutes after the crash, the first survivors were struggling through deep snow towards the airport. Having ascertained that the chance of extracting survivors from the now-burning wreckage was zero, the CRF initially concentrated on dealing with the injured. The inquiry found that the failure to deploy hand-lines to the accident had no bearing on the survival prospects of those who died in the accident. However, it became clear that the accident was actually in the area for which the Dryden municipality had responsibility, and there were command and control issues that would not have occurred had realistic training exercise been held; this was again the subject of a recommendation.

The regulator

This accident was notable for the number of recommendations made of Transport Canada as the regulator. In ascribing probable cause, Moshansky stated: "...the pilot-in-command, must bear responsibility for the decision to land and take off in Dryden on the day in question. However, it is equally clear that the air transportation system failed him by allowing him to be placed in a situation where he did not have all the necessary tools that should have supported him in making the proper decision."

The first 171 recommendations in the report were all addressed to Transport Canada. They range from the hiring of suitable experienced staff to the need for adequate oversight of commercial operators, and include the need to review and revise its operator audit process. One recommendation was: "That Transport Canada establish a policy that identifies surveillance of existing air carriers as a non-discretionary task." A large number of recommendations pertained to Air Ontario and the F28 programme, where shortcomings in training and equipment, coupled with inappropriately qualified or experienced managers, had led to a situation where commercial pressures had over-ridden good safety practice.

Two recommendations sum up the tenor of the report:

"Transport Canada put in place a policy directive that if resource levels are insufficient to support a regulatory or other program having a direct bearing on aviation safety, the resource shortfall and its impact be communicated without delay to successively higher levels of Transport Canada management until the problem is resolved or until it is communicated to the Minister of Transport".

"Transport Canada establish a mandatory education program to ensure that senior managers and officials of the department who are responsible for or associated with aviation programs are aware of the basis for and the requirement to support policies that affect aviation safety".

Transport Canada is a very different organisation from the one that existed at the time of the Dryden accident. Air Ontario also underwent significant change and after a period under direct Air Canada control is now a part of Jazz. The full Moshansky report can be viewed at http://publications.gc.ca/collections/collection_2014/bcp-pco/CP32-55-1-1992-1-eng.pdf

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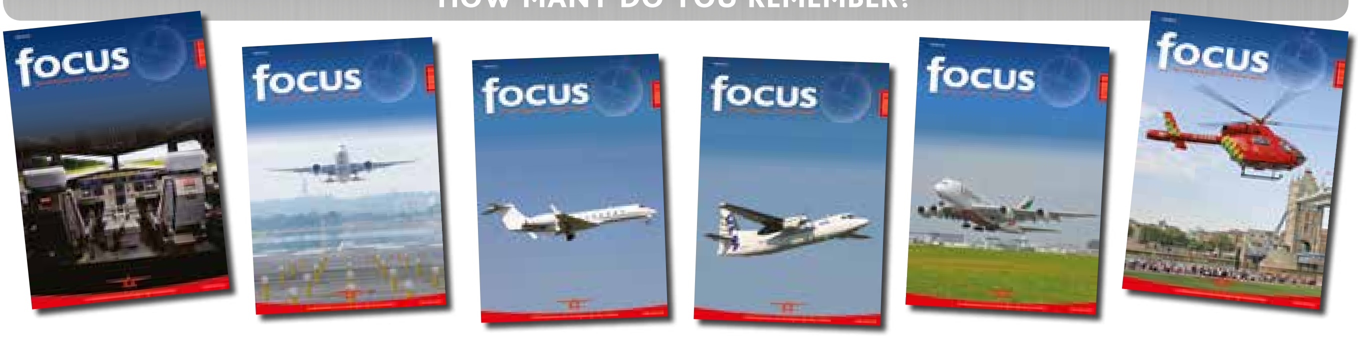

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