THE INVESTIGATOR

UAE General Civil Aviation Authority
Air Accident Investigation Sector

Volume 1 Issue 10, June 2018

INCLUDED IN THIS ISSUE:

- AIRMANSHIP 1 - FINAL APPROACH SITUATIONAL AWARENESS
- GCAA DEVELOPMENT OF HELIPORT MOBILE DASHBOARD
- DOWN AND OUT: THE HAZARDS OF WAKE TURBULENCE
- INVESTIGATING AN MD-80 RUNWAY EXCURSION

24 Hour AAIS Duty Investigator Contact Details

To make an immediate notification of an Aircraft Accident or Incident:

Hotline: +971 50 641 4667

This number is to be used only for notification of an Accident or Incident

E-mail: aai@gcaa.gov.ae

REPORTING OF SAFETY INCIDENTS

RISE HIGH WITH SAFETY

VOLUNTARY REPORTING SYSTEM

www.gcaa.gov.ae/en/vorsy/eform.aspx

REPORT SAFETY HAZARDS

Table of Contents

Editor in Chief

H.E. Saif Mohammed Al Suwaidi
Director General
General Civil Aviation Authority

GCAA Publisher

Eng. Ismaeil Al Hosani
Assistant Director General
Air Accident Investigation Sector
iwahed@gcaa.gov.ae

GCAA Editor

Tom Curran
Chief Air Accident Investigator
tcurran@gcaa.gov.ae

GCAA Corporate Communication

Khazna Al Mentheri
GCAA - AAIS Administrator

The Investigator is a non-profit GCAA publication and is published solely in the interest of Aviation Safety.

Comments and suggestions are very welcome. Please contact:
Tom Curran; tcurran@gcaa.gov.ae

Foreword by H.E. Saif Mohammed Al Suwaidi

Director General - UAE General Civil Aviation Authority

For Air Safety 2017 was a unique year. It was the first year in the history of commercial aviation during which no fatal aircraft accident occurred anywhere in the world. This is indeed a remarkable achievement considering that during the twelve-month period over four billion passengers flew on more than 38 million flights. In addition to the astonishing numbers the complexity of the aviation system, and of the environment in which commercial flights operate, must be considered to fully realise the magnitude of this achievement.

The unprecedented level of safety achieved is due to the commitment of the aviation professionals who work in all areas of the commercial aviation system including airlines, manufacturers, airports, air traffic control, aircraft maintenance and ground handling organisations and State regulation authorities. Safety has always been prioritised in aviation and change has always occurred at a conservative pace which has contributed to lower risk exposure.

The next goal is to strive to make the level of safety achieved in 2017 achievable in future years. This will be difficult as it commits the commercial aviation industry to sustain a level of continuous improvement in safety which must outmatch the risk posed by the continuous increase in the number of flights operated.

We must continue to improve the accident prevention defences built into aircraft and air traffic control systems and other systems across the aviation industry. Training for personnel in all areas of commercial aviation must remain up to date and be continuously improved. The aviation philosophy of safety management and safety oversight must be maintained and an appropriate balance between increasing commercial imperatives and safety priorities sustained.

Foreword by Eng. Ismaeil Al Hosani

Assistant Director General - AAIS

The 49th Seminar of the International Society of Air Safety Investigators will take place at the Intercontinental Hotel, Dubai from 29 October to 1 November 2018. The theme of the Seminar is "The Future of Aircraft Accident Investigation" and the event will attract a worldwide attendance of more than 300 State, civil aviation and military Air Accident Investigators and aviation safety managers.

This is the first occasion on which this important seminar will take place in the Middle East and North Africa region. It presents an opportunity to become acquainted with the latest developments in accident and incident investigation practices, techniques and equipment. I would like to encourage safety investigators and managers to attend the Seminar and the Tutorials that precede it on 29 October. The GCAA is proud to be associated with the ISASI 2018 Seminar as a sponsor and participant.

In addition to its core safety function of investigating aircraft accidents and incidents AAIS has been engaged in other activities recently, among which were the provision of investigation training by two AAIS investigators to Bahrain State and industry investigators, and training in ICAO Annex 13 investigation standards and practices was provided to UAE Accountable Managers.

The Air Accident Investigation Sector has moved to new offices on the second floor of GCAA Headquarters in Abu Dhabi. Our Dubai office is located in the Emirates Investment Bank Building at Festival Boulevard and Marrakesh Street.

I look forward to seeing you at the ISASI Seminar and Tutorials in Dubai.

Khalid Walid Al Raisi

Director Air Accident investigation

ICAO Fourth Air Accident Investigation Panel Meeting

An AAIS team, encompassing Khalid Al Raisi, Director Air Accident Investigation, and Ibrahim Addasi, Chief Air Accident Investigator, attended the fourth annual meeting of the ICAO Air Accident Investigation Panel (AIGP/4) which was held in Montreal, Canada, from 8 to 11 May 2018.

The participants who comprised representatives of various State accident investigation authorities discussed 12 working papers and 6 information papers. The subjects covered topics important to the international aviation safety and accident investigation community. The GCAA AAIS submitted a paper on "Competency-based Training for Investigators" for evaluation by the Panel. The working paper and its attached draft guidance material will be distributed to the Panel members for their comments before it becomes an official ICAO manual.

In addition, the AAIS team participated constructively in discussions on working papers presented by other participants. The AAIS team shared ideas and opinions that were well-considered by the Panel and many of them led to amendments to the working papers.

The Air Accident Investigation Panel was formed to support the ICAO Air Navigation Commission (ANC) in raising the international Standards and Recommended Practices in air accident investigation. Normally, the Panel's decisions and conclusions go through an ICAO process for approval before they come into effect as an amendment to Annex 13, or another ICAO Document.

ICAO AIG Panel Members

Captain Tony Wride

Manager Safety Risk,
Etihad Airways

Airmanship 1 – Final Approach Situational Awareness

This is the first of a series of articles covering airmanship.

Some recent incidents have highlighted that perhaps, with an over-reliance on automation, some basic airmanship skills may have deteriorated with a resultant risk to the safety of commercial aviation. I should stress that what I am focusing on in this article is not manual flying skills, but the other skills that should be applied whether in automatic or manual flight, and particularly during an approach.

In a recent incident a large commercial airliner descended to 400ft AAL 8 miles from the runway threshold. In another incident a large aircraft descended to 170ft rather than 700ft during an approach which apparently frightened the occupants of a hotel! In both of these incidents the aircraft carried out a go-around but in March 2015 an A320 at Halifax Nova Scotia (figure 1) impacted the ground 740ft before the runway threshold when the go-around was commenced too late to avoid ground contact.

Figure 1.

In August 2014 there was a fatal crash (Figure 2) when a cargo aircraft struck the ground approximately 3,300ft short of the runway (Figure 3) threshold during a localizer non-precision approach.

Figure 2.

Figure 3.

Both accidents and the two recent incidents raise a concern about what the pilots were looking at and doing at this very critical phase of flight. To descend 2,000ft below the normal height expected during an approach, as occurred during the first mentioned incident, with a serviceable radio altimeter correctly indicating the proximity of the ground and the descent continuing is cause for concern.

Airmanship is a term not often used nowadays and the term Situational Awareness has partially replaced airmanship when discussed in such forums as training.

From the very first flight by the Wright brothers in 1903 they soon learnt that certain things looked and felt right, while other things did not.

Figure 4.

First fatal airplane crash September 1908 - Lieutenant Thomas Selfridge killed and Orville Wright injured

Wikipedia has quite a good definition of airmanship;

*"**Airmanship** is skill and knowledge applied to aerial navigation, similar to seamanship in maritime navigation. Airmanship covers a broad range of desirable behaviors and abilities in an aviator. It is not simply a measure of skill or technique, but also a measure of a pilot's awareness of the aircraft, the environment in which it operates, and of his own capabilities.*

Airmanship can be defined as:

- *A sound acquaintance with the principles of flight,*
- *The ability to operate an airplane with competence and precision both on the ground and in the air, and*
- *The exercise of sound judgment that results in optimal operational safety and efficiency.*

*The three fundamental principles of expert airmanship are **skill, proficiency,** and the **discipline** to apply them in a safe and efficient manner. **Discipline is the foundation of airmanship.** The complexity of the aviation environment demands a foundation of solid airmanship, and a healthy, positive approach to combating pilot error."*

Let us look at some airmanship examples by conducting a little test related to a normal 3° approach path to a runway. The airfield elevation is 2,200ft.

1. At 10 miles from the runway approximately what indicated altitude would you expect? a) 2,600ft b) 5,200ft c) 3,700ft
2. At 8 miles from the runway approximately what indicated altitude would you expect? a) 2,600ft b) 5,200ft c) 4,600ft
3. Assuming that the terrain is flat at approximately what distance from the runway would you expect the Radio Altimeter to start indicating (2,500ft RA) a) 6 miles b) 8.3 miles c)10 miles
4. At 5 miles from the runway approximately what indicated altitude would you expect? a) 2,600ft b) 3,700ft c) 4,200ft
5. Do you brief, and crosscheck during an approach, altitudes against distance and radio heights for the terrain situation a) Yes b) No

An approach is a particularly busy period of the flight which can be challenging in adverse weather conditions and therefore discipline (as highlighted in the Airmanship definition) is paramount. Standard Operating Procedures (SOPs) help to maintain discipline by providing the safe procedures to follow. Sometimes not specifically mentioned in SOPs is the assumed discipline of airmanship where the pilots monitor the approach profile and know what heights to expect at certain distances from the threshold.

Quite often SOPs mention an Approach Fix as a crosscheck point or a distance from the threshold when the radio altimeter indicates 1,000ft. These are 2 examples but actually the height/distance to go crosscheck is ongoing and starts many miles from the airport as an indication for energy management. If we consider the first mentioned incident then at some point the radio altimeter started indicating (2,500ft RA) and this must have been well in excess of 10 miles from the threshold. This may not be unusual if a level segment of 2,500ft AAL is part of the approach. The 1,000ft RA indication however must have occurred at about 10 miles from the threshold, approximately 6.8 miles early, which is unusual.

Additional information regarding the use of the Radio Altimeter from various sources:

Radio Altimeter Awareness

On descent, once the radio altimeter is "alive", pilots should include it in the instrument scan for the remainder of the approach, to ensure that radio-altimeter indications are not less than the standard or average minimum obstacle clearance heights.

Unless the airport features high close-in terrain, the radio-altimeter reading (i.e. height AGL) should reasonably agree with the height above airfield elevation (i.e. height AAL), obtained by subtracting the airport elevation from the altitude reading when using QNH.

The radio altimeter is not, however, an easy instrument to monitor; its indications depend on the terrain being overflown, it does not fit naturally into the instrument scan, and any monitoring procedure that depends on pilot callouts based on the radio altimeter suffers from the same potential for high error rates as for those that are based on cross checking altitudes against DME. However, "automatic" callouts based on radio altimeter indications are extremely reliable. This is the basis for using the 1000ft RA automatic callout as a gross error check of the aircraft's position relative to defined instrument approach segments.

Unless the airport features high close-in terrain, the 1000ft RA auto callout should occur in the final approach segment, approximately 2-4 NM from the landing runway threshold. In preparation for any approach, pilots must determine both the source of "distance from landing runway threshold" information that will be used, and if local terrain is likely to cause an early or delayed auto-callout of 1000ft RA.

Additional guidance from a Training Department;

Radio-altimeter indications should not be less than the following obstacle-clearance minimum heights:

- 1,000ft during arrival until past the intermediate fix (except when being radar-vectored);
- 500ft until past the final approach fix FAF (or when being radar-vectored by ATC), and;
- 200ft from the FAF to a point on final approach where the aircraft is in visual conditions and in position for a normal landing (except during Category II/III approaches).

Given all of the above what lessons can we learn and apply when carrying out an approach?

- The correct vertical profile and awareness of the aircraft's proximity to the ground is paramount.
- The approach briefing must include the threats associated with the airport such as metric heights and conversion, terrain, and expected height against distance indications. Beware of distance indications not being co-located with the runway threshold, for example Bangkok 19R ILS/DME.
- The Radio Altimeter becomes a useful indicator once it 'comes alive' at 2,500ft and should be monitored and crosschecked against distance. Note that on approaches with variable terrain the radio altimeter height may be lower than expected as the terrain is overflown but very rarely is less than 1,000ft until within 5 miles of the runway. Terrain and expected indications should be briefed as part of the threat management.
- The Pilot Monitoring must be actively involved in confirming the safe trajectory of the aircraft and particularly highlight any deviation from the expected vertical path to the Pilot Flying.
- If there is any doubt about the vertical profile or lower than expected radio altitude indications occur then a go-around should be performed.

Depending on aircraft type you might find it useful to have the runway as a fix and then create 5 mile and 10 mile range rings to act as a crosscheck of altitude and distance. These 5 mile and 10 mile distances can then be included in the approach briefing as expected altitudes which becomes very relevant when the airport elevation is high.

All of the above has hopefully reminded you of a few points of Airmanship that you may have forgotten.

Good Airmanship Enhances Flight Safety

Answers:

1. b) 5,200ft - 2,200 airfield elevation + 3,000 based on 300ft per mile.
2. c) 4,600ft – 2,200 plus 2,400 based on 300ft per mile.
3. b) 8.3 miles
4. b) 3,700ft
5. a) Yes - If you currently do not brief these then consider doing so to manage the threats.

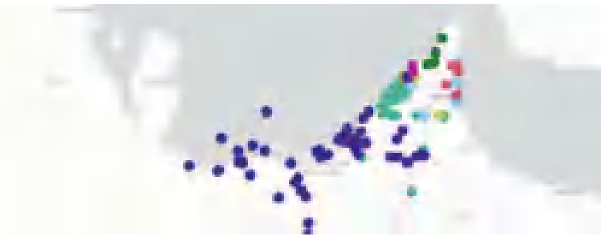
Michelle Soliman

Aerodrome Operations Inspector
GCAA

GCAA Development of Heliport Mobile Dashboard

The General Civil Aviation Authority (GCAA) of the United Arab Emirates (UAE) developed a Heliport Dashboard in 2017 as an initiative to enhance stakeholder communication channels under its State Safety Programme and in the spirit of the UAE National Strategy for Innovation.

The enhanced information display system was developed in response to the GCAA's ever expanding mandate to oversee safety in a rapidly expanding civil aviation system and to ensure helicopter operators in the UAE can quickly find and filter information about the location and characteristics of the heliports registered with the GCAA. The information serves to support medical emergency, humanitarian and royal protocol operations and ensures that consistent and accurate information is provided through an intuitive interface in real-time.

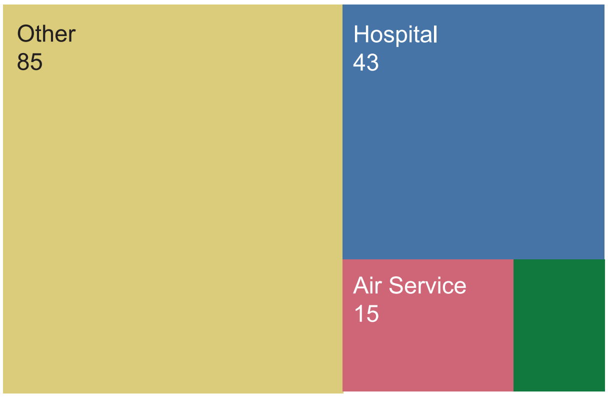


UAE Heliport Dashboard (2017)

Background

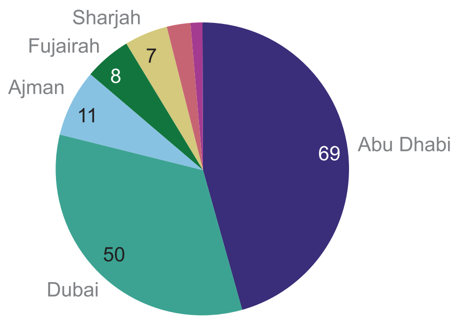
Historically, safety oversight of aerodromes focussed on the eight UAE international airports; however, over the last decade this limited perspective was challenged by the GCAA leadership under its State Safety Programme.

The definition of an aerodrome, according to the International Civil Aviation Council (ICAO) is any "defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure, and surface movement of aircraft." The Air Navigation & Aerodromes (ANA) Department and the Aviation Safety Affairs Sector were presented with the formidable challenge to ensure all UAE aerodromes, including domestic airports, airfields, water aerodromes and heliports (including offshore helidecks) were subject to safety oversight.



Heliports by Type of Service
UAE Heliport Dashboard (2017)

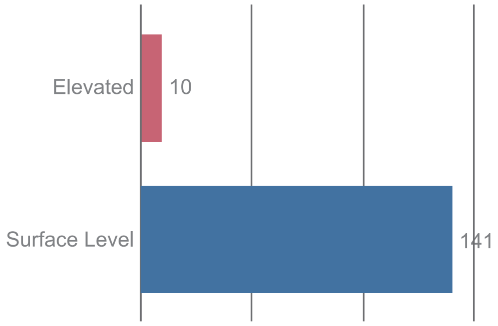
The expanded oversight process began in 2008 with an inventory of aerodromes which were not subject to GCAA safety oversight. Over 500 aerodromes, as per the ICAO definition, were identified through liaison with the GCAA's Flight Operations Department, helicopter operators and the petroleum industry. These aerodromes were segregated by the ANA Department into colloquial sub-classifications including heliports, helidecks, aerodromes and airports, with the term "aerodrome" generally referring to private use airfields and "airport" referring to airfields with international passenger facilitation facilities.



Heliports by Emirate
UAE Heliport Dashboard (2017)

The term "heliport" is colloquially used by the GCAA as a reference to only surface level and elevated heliports. "Helideck" is used to refer to an off-shore heliport on a structure.

The second stage of oversight included the development of regulatory and guidance materials for heliports and helidecks further to extensive industry consultation. Civil Aviation Regulation Part IX: Aerodromes, in conjunction with Civil Aviation Advisory Publication (CAAP) 30: The Issue & Verification of an Aerodrome Certificate, was used as the basis to certify the first heliport, Burj Al Arab Heliport, in the UAE in December 2014. Also in 2014 CAAP 70: Heliports: Air Service & Private Use was published, followed in 2016 by CAAP 71: Helidecks (Off-Shore). These publications established a bespoke framework for the segment of the aviation industry involved with helicopter and heliport operations. Whilst the safety oversight regime for helidecks focuses primarily on the operating organisations in the oil and gas industry; the GCAA made the determination that heliports would be subject to acceptance and oversight on a facility-by-facility basis.



Heliports by Structure
UAE Heliport Dashboard (2017)

This close management of heliports resulted in an extensive GCAA heliport database which includes the physical details, operator contacts and a cloud-based document repository holding the archives and transactional records for each facility.

This information was not necessarily subject to promulgation through the UAE Aeronautical Information Publication (AIP) issued by the UAE's Sheikh Zayed Air Navigation Centre's Aeronautical Information Services. The AIP contains aeronautical information of a lasting character essential to air navigation.

With an abundance of raw data regarding heliports not available to users of the aviation system; the ANA Department realised there was an opportunity which would have tremendous benefits for the heliport operators within the UAE.

UAE National Strategy and Safety Program

The National Strategy for Innovation seeks to stimulate practical initiatives in seven priority sectors including Transport with an aim to provide new products and services, make procedures more effective, and to save time.

As part of the UAE State Safety Programme's pillar for Safety Promotion, the GCAA commits to External Training, Communication and Dissemination of Safety Information.

The ANA Department and Aviation Safety Affairs Sector

Courtesy of helidubai

seized on the prospect of creating a platform in which information regarding heliports could be shared for the benefit of the UAE aviation industry. This data not only has potential to provide geographic and contact information to interested parties; but may also serve as a foundation to protect the airspace around these facilities through integration with existing GCAA applications such as the UAE Drone Fly Zone.

During the 2017 Dubai Airshow the GCAA unveiled the first version of the Heliport Dashboard. The current dashboard includes details of 151 heliports located in each of the seven emirates of the UAE and targets users in the aviation sector including public, private and police helicopter operators who transport injured people to hospitals, perform search and rescue activities, or transfer passengers.

The dashboard currently has a restricted number of users, noting privacy concerns regarding publication of information about private use heliports. It is envisaged that a public version of the dashboard will become available in the future, while restricted users such as other government entities, including the police and emergency services, will enjoy unfettered access to the coordinates, contacts and classification maintained as part of the GCAA's certification, acceptance and oversight services.

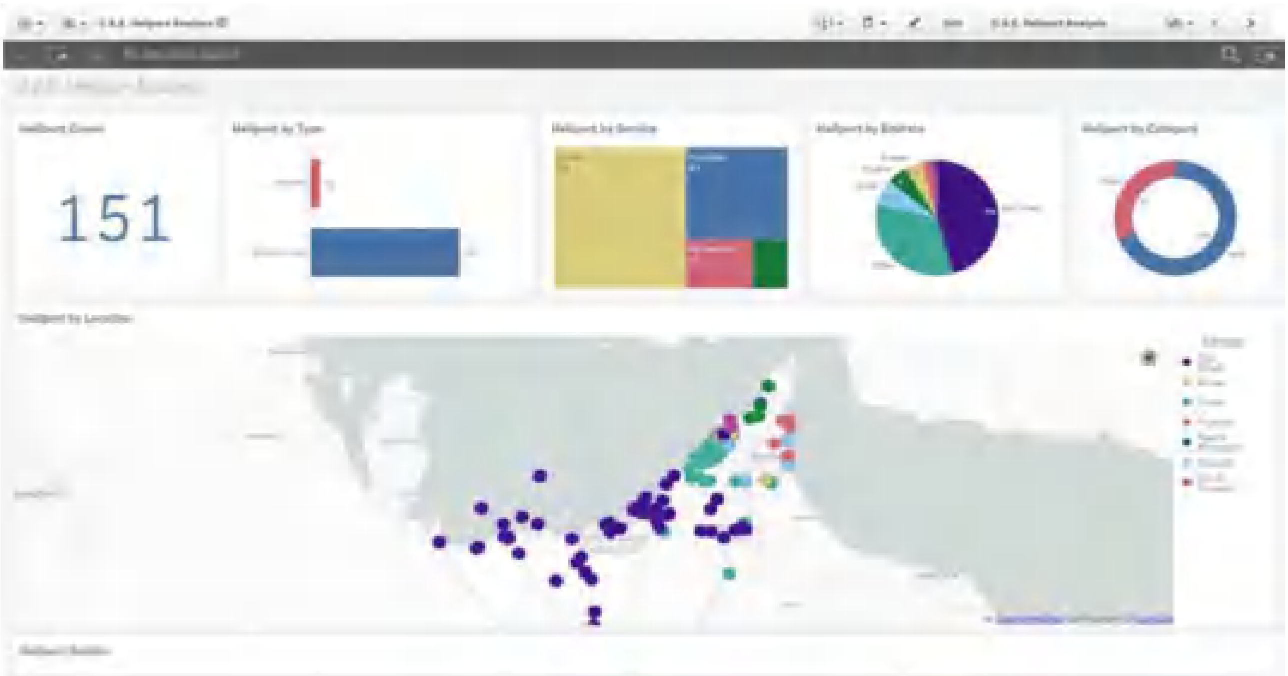
Further to development of the Heliport Dashboard, H.E. Saif Mohammed Al Suwaidi, Director General of the GCAA, commented: "The General Civil Aviation Authority seeks to play its role in the development of the country and to enable the civil aviation sector to contribute to the achievement of the government's strategy.

The dashboard is the first of its kind to be used by the helicopter industry, as it is usually the case that information is available manually and not updated. The application will target the provision of humanitarian services, where dynamic data will be available for all hospital heliports, in addition to the airfields located in remote areas and major cities, thus facilitating helicopter users to carry out their tasks effectively."

The dashboard fulfils mandates from both the State Safety Programme and National Strategy for Innovation. This tool represents multi-channel communication of safety relevant information taken from heliport applicants, vetted by the GCAA further to its responsibilities for aviation safety, and then ultimately provided to the end users in support of their helicopter operations. This typifies a success of the extended scope of the UAE State Safety Programme through management and development of interfaces between a wide spectrum of regulated entities sharing the responsibility for the safety of air operations.

Achieving acceptable levels of safety globally, regionally and locally requires that the interfaces between industry stakeholders are managed consistently. The commitment of the GCAA to e-services, data management, industry engagement and the development of services such as the Heliport Dashboard exemplify successful implementation further to the State Safety Programme and the UAE National Strategy for Innovation.

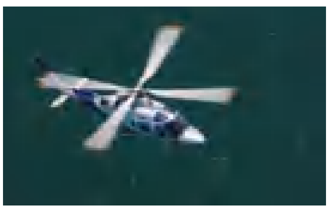
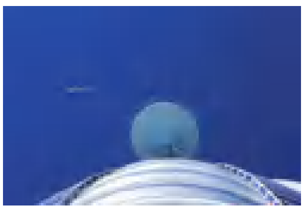
HE Saif Mohammed Al Suwaidi, Director General GCAA (L), and Mohammad Al Dossari, Director Air Navigation & Aerodrome Department, during launch of Heliport Dashboard at 2017 Dubai Air Show.

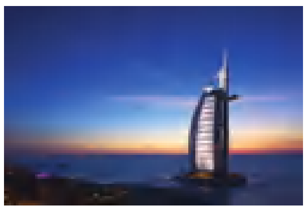


UAE Heliport Dashboard (2017)

The Author:

Michelle Soliman is an Aerodrome Operations Inspector with the General Civil Aviation Authority in the United Arab Emirates and Visiting Lecturer for aviation programmes with City University of London. After concluding her career as a Captain in the US Air Force, Michelle held senior commercial and IT roles with Sydney Airport Corporation and served as CEO of Ras Al Khaimah Airport before joining the GCAA.



Courtesy of helidubai

Vortex Ring State

Vortex ring state is a serious hazard all helicopter pilots need to be aware of Vortex ring state occurs when a recirculation vortex envelops a helicopter's rotor system, causing significant loss of lift.

This can occur when the helicopter is descending at a reduced airspeed, and is most at risk of happening during downwind approaches. The likelihood of vortex ring state is increased with a helicopter at a heavier weight due to a higher power setting requirement.

The condition can be sudden, and it results in a rapid increase in rate of descent. Any increase in rotor thrust to reduce this further energises the vortices and increases the rate of descent.

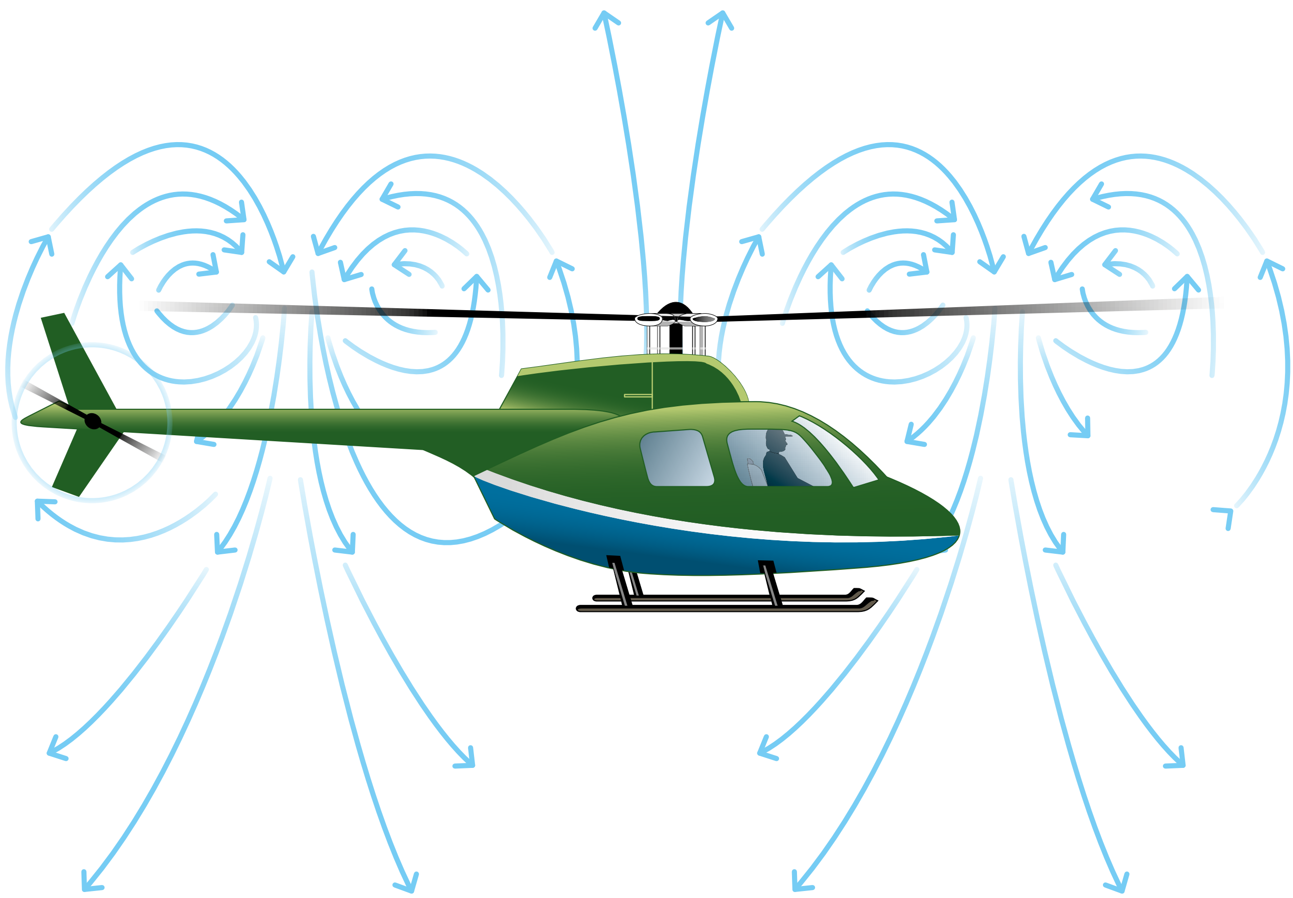
The standard vortex ring state recovery technique requires pilots to reduce power by lowering the collective and accelerating forward away from the downwash. However in the low level environment this may not always be possible as it consumes valuable height.

Alternatively, the Vuichard Recovery technique can be used to move out of the vortex ring. This involves increasing collective to climb power, applying the appropriate pedal (generally left in American helicopters, and right in European helicopters) to keep the nose straight, and applying the appropriate cyclic (opposite to the pedal used).

Of course, avoiding vortex ring state is the best course of action. This requires pilots to:

- Remain alert to the conditions conducive to the formation of vortex ring state
- Closely monitor the airspeed and rate of descent during the final approach
- Initiate recovery action at the first indication that they may be approaching vortex ring state.

Reprinted by kind permission of the New Zealand CAA Vector safety publication.



Normalisation of Deviance

How is it that trained pilots and other aviation professionals can deviate from required operating practice?

In New Zealand, a flight was chartered to take a VIP to an important meeting. The VIP arrived late, but the crew got them to the destination on time. The VIP wrote to the CEO praising the pilots for their sterling service. The feedback was passed on in person by the CEO – big smiles all round. Unbeknown to management, the crew had skipped most of the pre-flight and take-off checks.

That's just one episode psychologist Keith McGregor can recall, during his many years studying organisational and human factors.

Keith was an air force psychologist for 12 years before becoming a consultant with the Transport Accident Investigation Commission (TAIC). Keith says analysis of both accident and non-accident flights will often reveal deliberate deviations from standard operating practices, despite no critical need to do so.

Flying below minima has been a contributing factor in fatal accidents in New Zealand with investigators sometimes discovering it had become normalised practice.

American sociologist Diane Vaughan coined the term 'normalisation of deviance' and defined it as "the gradual process through which unacceptable practice or standards become acceptable. As the deviant behaviour is repeated without catastrophic results, it becomes the social norm for the organisation."

Vaughan developed her theory when she was investigating the space shuttle Challenger accident which exploded shortly after liftoff on 28 January 1986. She observed that the cause of the disaster was related to the practice of NASA officials allowing space shuttle missions despite a known design flaw with the O-rings in the solid rocket boosters.

Normalisation of deviance, non-conformity, call it what you like. But chances are you probably know or have heard of someone who behaves this way. Perhaps you saw something you knew to be unsafe, but did nothing about it? Maybe it's you?

Maybe you are the VFR pilot pushing the limits flying in less than ideal VFR weather. The pilot who doesn't want to put the defect in the tech log that grounds the aircraft and upsets the boss? The engineer who is rushed for time and signs off the paperwork saying the duplicate inspection was done, even though you know it wasn't done completely?

"The desire or need to 'fit in', to please others, or to keep the boss happy is understandable. The reward or feelings of satisfaction you get from completing a task quickly is appealing."

CAA analyst Joe Dewar says it's seen in a range of accidents and incidents in New Zealand, that people have operated outside of standard procedures or operating limitations.

"A classic case would be an aircraft which is certified to carry no more than x-amount of weight for a given set of conditions. But despite this, the decision might frequently be made to load beyond this. And this might be done more and more often. For a number of flights this might have been fine. But suddenly conditions change – perhaps in air temperature or wind intensity – and the aircraft is now overweight for the conditions. Its performance completely changes and it cannot be controlled. In that instance, the overloading has been normalised over a period of time… and then bang."

TAIC's investigation into one fatal crash found the pilot was reported to have carried out unnecessary low flying on scenic flights on a number of occasions – possibly to give the passengers a thrill – over several years.

TAIC found the operator did not adequately supervise the pilot, independently investigate an allegation of the pilot low flying, or establish a system to control or monitor the pilot's performance and compliance with safety requirements.

Falling into the trap

Why do trained pilots and aviation professionals fall into this cycle?

Keith McGregor says in considering the VIP flight, the pilots knew what they were doing was wrong and no doubt reassured themselves it was a 'one-off'.

"But they were rewarded with praise from the boss, and faced with a similar situation in the future, the probability that they would repeat the deviance had been slightly increased. For humans, one of the most powerful forms of feedback is attention, and in this case they received plenty."

Joe Dewar says commercial pressures can be a major contributing factor.

"The incentive is there for pilots to operate outside standard procedures or limitations, and cost is a big part of that."

Keith says diligently following standard operating practices can involve operational and commercial penalties.

"Flights may be delayed, cancelled or diverted, and significant extra costs may be incurred, and that can result in a good deal f grief for the pilot."

CAA Air Transport Inspector Pete Wilson has a Masters in Human Factors and Safety Assessment in Aeronautics and has flown for airlines overseas.

Pete says while most work environments encouraged strict adherence to safety practices, not all were conducive to achieving this.

“At one place, pilots weren’t recording defects in the aircraft technical log - so much so I got called in to see the chief pilot to be told I was putting too many defects in. When I pointed out I was the only pilot putting things in the tech log and nothing would get fixed otherwise, he realised there was a roblem with the culture.”

Pete says pressure – be it due to commercial needs or concern about how your peers regard you – is hard to ignore.

“The desire or need to ‘fit in’, to please others, or to keep the boss happy is understandable. The reward or feelings of satisfaction you get from completing a task quickly is appealing.

“No organisation is immune – ‘normalisation of deviance’ has been shown to exist right across the aviation spectrum, from NASA to airlines, military jet display teams, maintenance organisations, biz-jet operators, right down to the smallest sightseeing company.”

Keith says from a psychological perspective, acting safely is a self-defeating behaviour.

“The fundamental thing is the extent to which senior management are genuinely aware of what happens. What sort of workarounds are people doing in order to get the job done?”

“If you do it right, nothing happens – which means the behaviour is not reinforced, but take a shortcut to get finished earlier, and bingo, the unsafe behaviour is rewarded.

“Without even realising it, you start cutting corners and now that process will basically become normalised because it gets reinforced.”

Reinforce the positive

Joe Dewar says the roots of ‘normalisation of deviance’ usually lie in the environment in which they occur.

He says where there is less structure and supervision within an organisation, it’s a phenomenon that occurs much more readily.

So CEOs and managers need to look at what they’re doing at the organisational level.

“Instead of solely focussing on occurrences, if you’re the CEO or a Senior Person you also need to keep an eye on things consistently being performed correctly. So for example, do you have oversight of whether your pilots always follow the same checklist each flight? Do the aircraft fly within limits? It’s good safety management to pay attention to these procedural aspects of operations, to avoid drifting into failure.”

In his investigation work with TAIC, Keith says it was amazing how often there was a 180-degree difference between what management told them was happening on the ground, versus what the people on the ground told them.

“The fundamental thing is the extent to which senior management are genuinely aware of what happens. What sort of workarounds are people doing in order to get the job done?”

He says managers forget that when an organisation acts safely, nothing actually happens.

“Every organisational survey you do, you see people in the open comments section saying ‘the only time we hear from our managers is when something’s gone wrong’. There should be a huge onus on management to actively pay attention to safe behaviours and focus on what people are doing well.”

Mitigation strategies

Pete says neutral observers are usually better at spotting bad news, so things like audits are a good opportunity to pick up on whether poor practices may be creeping in.

He says management needs to be clear about what the standards are, and reward whistle blowers.

“Also, think about how your behaviour is shaped by others you observe and vice versa. Imagine an experienced pilot in a small company exhibiting poor standards or behaviour – how likely is it others will copy them?”

Keith says empowering others to speak up is an effective way to stop unsafe behaviours becoming normalised.

“Establish an agreement with other pilots for instance, that they will ask you to explain the reason for any deviation they notice and vice versa. We are generally better at spotting other peoples’ deviations than our own. If you actually ask them to do it, they’re more likely to be upfront.”

Keith says pilots should be encouraged to take ownership of their actions.

Joe agrees that a deep-seated sense of responsibility should be at the core of pilot training.

“When pilots are trained, the critical importance of the pre-flight checklist should be engrained, for example. That means even when there is no pat on the back for doing it, you recognise you always have to do it.”

Reprinted by kind permission of New Zealand CAA Vector safety publication.

Robert Bara

Air Navigation Inspector

Special use of Airspace
General Civil Aviation Authority Role

The celebrations of special events in the UAE are amazing for their colorful fireworks and perfectly synchronized laser shows, which create a very special festive atmosphere. There is almost no celebration, particularly those for the National Day or New Years' Eve, that are without a fireworks display and/or a laser show.

All these activities creating a special atmosphere, delighting the crowds from the youngest to the eldest. At the same time, they could pose potential hazards to aviation if they were not properly organized, assessed and conducted.

Under certain conditions, laser light, or other bright lights (spotlights, searchlights), directed at aircraft could pose a hazard. A bright visible laser light could cause distraction and startle, or even result in temporary flash blindness or eye damage to a pilot during a critical phase of flight such as landing or takeoff. Such an occurrence could lead to significant consequences.

Most reports referring to fireworks and lasers involve general aviation pilots who report having been startled and/or lost their night vision and had their situational awareness affected.

Behind the beauty and excitement generated by these shows, a lot of effort is expended in organizing the events to ensure safety and eliminating all potential risks to aviation.

The General Civil Aviation Authority (GCAA) is an important player in this process, as it is the competent authority mandated to establish procedures for the approval of special use airspace and also for implementing the procedures.

As per the National Regulations, the organizers of these events are requested to notify the GCAA Air Navigation & Aerodromes (ANA) Department about the activity and GCAA approval must be obtained prior to the event.

Applications to hold events, including all the supporting documents, are submitted online by the show organizers through the Air Navigation & Aerodromes e-Services portal and they are processed by the departments' inspectors.

The applications are initially received by the coordinators, who check the oganizers documentation to ensure they adhere to the regulatory requirements. If compliance with the regulation is verified, the Air Navigation Inspectors conduct a safety risk assessment in coordination with the relevant air traffic services providers responsible for the area where the event is to take place.

Based on the location, timeframe, maximum height of the operations, horizontal range and the feedback provided by the air traffic services involved, the application may be approved, it could be approved under some restrictive conditions which will mitigate the identified hazard or it could be rejected. If it is identified as being a hazard to air operations.

Once final GCAA approval is granted, a NOTAM (Notice To Airmen) is issued in order to inform the air operators about the location, height, range, timeframe and other conditions of the event. In this way, all UAE airspace users will be notified about the occurrence of these activities, assuring safe air operations.

All of this type of entertainment activities organized within UAE airspace, such as fireworks, laser shows or balloon launching shows are regulated, assessed, coordinated, approved and monitored by the Air Navigation - Airspace Management team, which ensures that air operations are always conducted in a safe manner, while the public are enjoying the show.

In 2017, the General Civil Aviation Authority - Air Navigation - Air Space Management team processed 392 applications with a peak of applications occurring during the final quarter of the year. The occasions of the National day and the New Years' Eve celebrations were particularly busy when 130 applications were processed.

No incident related to Objects Affecting Airspace has ever been recorded in the UAE and this indicates that the oversight, coordination and approval system implemented by the General Civil Aviation Authority is robust, safe and efficient. Having said this, as every aviation professional knows we must always be aware of potential risks and never become complacent. The Air Space Management team is committed to maintaining the UAE record of safe event operations.

Robert Bara

Robert has been a General Civil Aviation Authority Air Navigation Inspector since 2016. From 2012 he worked with GAL ANS as AIM & Aerodrome Safeguarding Manager of the Abu Dhabi Airports Company. From 2007 to 2012 Robert held the position of NATO/ISAF KAIA -AIS Senior Manager. Prior to this he was an Air-Force Officer - Air Traffic Controller & Intercept Controller.

Down and out:
The hazards of wake turbulence

Flight Safety Australia Staff Writers

© *iStockphoto.com | David Birkbeck*

On 7 January 2017, a German registered Bombardier Challenger C604 business jet with three crewmembers and six passengers onboard, encountered wake turbulences over the Indian Ocean at flight level 340, after an Airbus A380 passed in the opposite direction at flight level 350. The C604 entered a spin and in the following 32 seconds, lost approximately 8,700 feet in altitude. The aircraft reached an airspeed of 330 knots and the left engine auto shutdown. After the pilot regained control of the aircraft, the engine was restarted and the flight diverted to Muscat, Oman. Two passengers were severely injured, another two passengers and the cabin crew member sustained minor injuries. The aircraft exceeded its design load limitations during the upset encounter and was subsequently written off.

The German Bundesstelle für Flugunfalluntersuchung (BFU) is investigating the accident as the State of Registration, because the event occurred in international airspace (Report BFU17-0024). The Air Accident Investigation Sector (AAIS) of the United Arab Emirates, together with investigation authorities of Oman, France, the United States and Canada assist the investigation with Accredited Representatives.

The following article, published in the Flight Safety Magazine of the Australian Civil Aviation Safety Authority, provides information and some strategies for pilots to safely react to wake turbulence events.

An incident in January 2017 in which a Challenger business jet was severely damaged after flying into wake turbulence from a Sydney-bound Airbus A380 focused attention on what can happen when large and small aircraft share the same airspace.

One passenger in the Challenger was seriously injured and several others hospitalised. The aircraft, which had been flying at flight level 340, rolled at least three times, lost about 10,000 ft and flamed out before making an emergency landing in Muscat. The damage was so severe the aircraft was written off.

While a serious incident, it was by no means the first involving wake turbulence from an A380. The following are some examples involving Australian-registered aircraft:

- On 14 September 2012, a Virgin Australia Boeing

737-800, en route from Denpasar to Brisbane, encountered wake turbulence south of Bali from an A380 travelling in the opposite direction 1000 ft above, about 2 nm behind, and slightly left of the Boeing's track. The aircraft rolled initially to the right, then to the left, with a maximum left-bank angle of about 40 degrees.

- On 16 October 2011 over Germany, a westbound British Airways A320 on climb from FL320 encountered severe wake turbulence from an eastbound Qantas A380 at FL330. The A320 was subjected to forces of up to +1.93G and rolled between -26 degrees and +32 degrees. Four passengers suffered minor injuries.
- On 3 November 2008, the crew of a Rex Saab 340B reported a temporary loss of control while about 7 nm from touchdown and turning onto final approach for runway 34R at Sydney. The Saab rolled 52 degrees to the left, then 21 degrees right, pitched down 8 degrees and lost between 300–400 ft in altitude. One person suffered minor injuries. The Australian Transport Safety Bureau (ATSB) found that the cause was wake turbulence which had drifted in a westerly crosswind from an A380 operating about 3.4 nm ahead on the parallel runway 34L. The ATSB calculated that with winds of about 35 knots at 2400 ft, the A380's wing vortexes took 72 seconds to cover 1300 metres.

There have also been numerous wake turbulence events involving aircraft of different sizes, so this is a topical issue for all aviation operations in Australia.

Diagram: Juanita Franzi

What is wake turbulence?

Wake turbulence is an inevitable by-product of flight. It's the result of differential pressure between the upper and lower surfaces of a fixed or rotating aerofoil. The turbulence is caused by the roll up of airflow behind the wingtips, creating a clockwise vortex behind the left wingtip and an anticlockwise one behind the right wingtip.

The vortexes are generated the whole time an aircraft is airborne. While generally only a few metres in diameter, they can be very intense, depending on the aircraft's weight, wingspan, configuration and attitude. Size really does matter, though there are exceptions; some aircraft, such as the Boeing 757, have a reputation for producing particularly intense vortexes.

What makes wake vortexes particularly dangerous is that they can persist some distance behind, and below, the aircraft generating them. En-route, an aircraft's wake can extend for more than 25 nm, and descend very slowly downwards and outwards—levelling off around 1000 ft below the generating aircraft.

This means encounters can occur when an aircraft passes below the flight path of another aircraft—even though ATC vertical separation is being applied. In the terminal environment, the concentration of aircraft of different sizes increases the risk of exposure to wake vortexes. This all means pilots have to be keenly aware of wake turbulence in all stages of flight.

Helicopters in forward flight produce wake turbulence as well, so the advice in this article is equally applicable when operating behind a larger helicopter.

Diagram: Juanita Franzi

What should pilots do in a wake turbulence encounter?

The downward or upward force from a wake turbulence vortex is likely to cause a following aircraft to initially roll in one direction. The natural reaction is to try to counter the roll with opposite aileron and rudder.

Counterintuitively, however, this is likely to make matters worse.

This is because as the aircraft enters the vortex, it is likely to experience a stronger roll in the direction of the vortex—opposite to that encountered initially. This second roll would be amplified by any force applied by the pilots to correct the initial roll. It is thought that such overcorrection contributed to the severity of the A380/ Challenger encounter.

Some aircraft flight manuals contain procedures to be followed in wake turbulence. In the absence of specific procedures, the advice is to avoid abrupt reverse control inputs, and instead allow the aircraft to pass through the vortex and then recover. In particular, pilots should not use rudder to counteract the effects of wake turbulence, because this can create forces beyond the aircraft's structural limits.

The advice is also to leave the autopilot engaged, but be ready to resume manual control if it disengages itself.

What should pilots do to avoid wake turbulence upset?

The most obvious solution is to avoid the vortexes from another aircraft in the first place.

En-route, you can offset from the route centreline-obtaining, if appropriate, ATC clearance or request a level change. But be aware vortexes drift with the prevailing wind, so offsetting on the wrong side can make things worse rather than better. Try to visualise any lateral movement of the wake vortexes as a result of wind and make your decision accordingly. Contrails from the aircraft ahead can assist in this regard.

In controlled airspace or at controlled aerodromes, air traffic controllers will apply wake turbulence separation between instrument flight rules (IFR) aircraft in flight and, for take-offs, between all aircraft-IFR or visual flight rules (VFR). Be aware that ATC wake turbulence separation does not enable an aircraft to completely avoid the effects of wake turbulence; it only mitigates the worst effects.

However, if the pilot of an IFR flight accepts a clearance to visually follow a preceding aircraft, the pilot is responsible for both separation and wake turbulence avoidance.

Controllers will provide a wake turbulence cautionary advice to all controlled flights if, in the controller's opinion, wake turbulence may have an adverse effect.

Where ATC is not providing wake turbulence separation-such as when a VFR aircraft is landing behind a larger aircraft-it is important to visualise the wake vortexes from the preceding aircraft and to take action to avoid the resultant wake turbulence. These actions can include:

- Adjusting your flight path to achieve a three-minute spacing between you and the aircraft ahead (ensuring you inform ATC about this)
- On departure, endeavoring to rotate prior to the larger aircraft's rotation point
- When landing behind a larger aircraft on the same runway stay at, or above, the larger aircraft's final approach flight path; noting the touchdown point and landing beyond it (being careful to avoid the possibility of a runway excursion)
- Avoiding a flight path that crosses the wake vortexes of a preceding aircraft
- If unsure on final approach-going around and making another approach.

Near helicopters

A hovering or slow hover-taxiing helicopter generates a downwash from its main rotor(s) that can be powerful and dangerous. Pilots of light aircraft, even when taxiing, should avoid operating within three rotor diameters of any helicopter in a slow hover taxi or stationary hover.

Published with kind permission of Flight Safety Australia

Accident Investigation Training in Bahrain 2018

Hans Meyer
GCAA - AAIS

Mohammed Abdul Bari
GCAA - AAIS

From 8 to 12 April 2018, the Aircraft Accident Investigation Sector of the United Arab Emirates held a basic Aircraft Accident Investigation training course to aviation professional in Bahrain.

The objective of the training was to provide the participants with the knowledge and skills to participate in an incident or accident investigation as competent team members.

The Bahrain Civil Aviation Authority invited Air Accident Investigators Hans Meyer and Mohammed Abdul Bari as presenters to share their knowledge and experience, and to provide the participants with the awareness and knowledge of the processes of an aircraft accident or incident investigation.

The participants came with a range of experiences, from the Director of Aviation Safety & Security and the Head of Standards Licensing & Development, the Manager Emergency Response Planning, Airworthiness Inspectors, Air Navigation Audit Specialists, Military Safety personnel, and qualified personnel from other aviation areas.

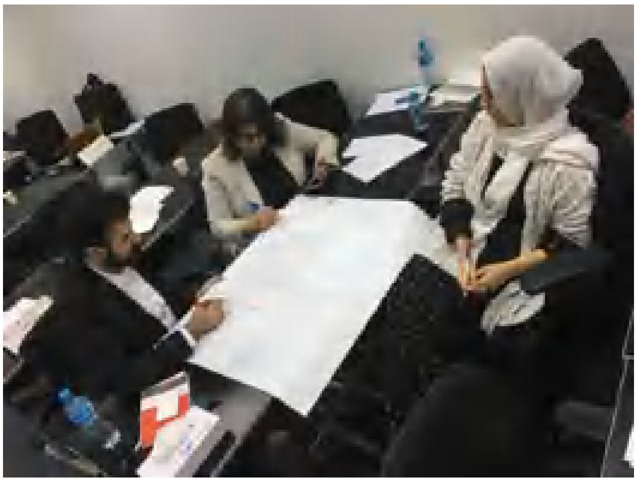
The training course was based on ICAO's Annex 13 and ICAO's Document 9756 – Manual of Aircraft Accident and Incident Investigation and covered a range of topics, including: the responsibilities of the States, the objective of accident investigations, the definition of accidents, serious incidents and incidents, the role and responsibilities of the Investigator-in-charge, Accredited Representatives, Observers and Technical Advisors, the composition of investigation teams, State's accident preparedness and the notification process, the investigator's go-kit, accident site management, the hazards at the accident site, accident site safety, personal protection, collection of evidence, managing the media, on-site and off-site investigation processes, witness interviews, handling and analysis of evidence, onboard recorder handling, wreckage reconstruction, crashworthiness and survivability, human and organizational factors, findings, as well as causes and contributing factors. The week finished with report writing and the importance of safety recommendations.

The participants discussed recent and historic accident scenarios and conducted group exercises in which they developed investigation tasks flow charts, identified hazards at different accident sites and recommended protective measures. The participants also identified

investigation team specialties for nominated accidents and developed specific questions for initial witness interviews. Each team nominated an "Investigator-in-charge" who then presented their work to the class.

While there was a lot of information to cover in these five days, the course was well received by the participants who are now looking forward to increase their knowledge with advanced courses.

Mr. Salah Mudara, the Treasurer of the MENASASI visited the course on the last day to inform the participants about ISASI's history, achievements and objectives. All participants were invited to attend the ISASI Seminar in Dubai on 29 October 2018. This training course was accepted by the MENASASI board members as part of the Reach-out program to enhance the investigation capabilities within the MENASASI region.



Tidy cockpit for safe flight

Xavier Barriola

Director Flight Safety
Accident investigator

David Marconnet

Flight Operations Safety
Enhancement Manager

One would not normally think of everyday life objects, apparently as inoffensive as a pen or a cup of coffee, as being a real threat to the safe operation of a commercial flight. Yet, leaving them unsecured or forgotten in a cockpit could rapidly turn them into real trouble makers…

At the beginning of 2014, the crew of a cruising A330 and their passengers unintentionally lived a new flying experience at negative g by night… The culprit? A digital camera left between the Captain's side stick and the seat arm rest that led to inadvertent nose down inputs as the PF seat was adjusted forward.

Loose Items In The Cockpit: Uninvited Guests!

Common sense generally instructs anyone in a cockpit to maintain an orderly environment. However, over the past decade, serious incidents involving unsecured or forgotten items have continued to happen. For the most part, being complacent is not intentional. It just happens.

But in view of the possible consequences, truly the cockpit must remain clean and tidy at all times during flight.

The resulting consequences

Investigations into the cited 2014 event showed that the camera had been left unsecured between the Captain's side stick and the seat arm rest, such that when the pilot moved his seat forward, it pushed the cam- era forward too, and eventually, the side stick.

The aircraft dutifully answered this side stick motion and abruptly pitched its nose down for around 20 seconds, reaching a maximum 15 000 feet a minute descent rate. When the aircraft entered this steep descent, the Captain was alone in the cockpit, in a night environment; therefore, during these 20 seconds it was necessary for him to analyse the situation properly, remove the camera, and eventually recover by pulling the stick back and stabilising the aircraft in a safe attitude.

4 000 feet were lost in altitude during the dive, after which the flight continued uneventfully, but a few passengers and crew members were injured in the process.

This event is just one in too many operational incidents over recent years where a loose item left unsecured or forgotten in the cockpit was involved. The following incident summaries, illustrate some common - and preventable - scenarios related to unsecured or forgotten items:

- During an aircraft landing, the rollout jerks caused the pilot's cap to fall off right onto the Park Brake handle

because the cap was hung too loosely. A jump seat rider present in the cockpit at that time, was quick to react and while attempting to secure the cap, inadvertently turned the Park Brake handle and set it ON. This obviously led to a rather abrupt stop and the aircraft tires to burst. Thankfully no one was injured in this event.

- On another aircraft in cruise, documentation that had been left on the center pedestal moved and interfered with the rudder trim knob. This resulted in a sudden rudder movement and unexpected aircraft yaw, from which the pilot managed to recover. Again thankfully no one was injured.

- An aircraft with moving throttles was approaching the Top Of Climb (TOC). At TOC, when thrust reduced, an iPad the Pilot had left on the throttle control module became jammed between the throttles and the fuel levers. When the Pilot removed his iPad, both fuel levers were activated, thus shutting down the two engines. The crew managed to recover the situation safely and no one was injured.

Other common situations are regu- larly heard of:

- Coffee cups placed on the glare shield or pedestal: unexpected turbulence or unintentional bumping by the crew causes fluid to be spilled onto the cockpit control panels. Beverage spill onto electronic equipment may not necessarily have an immediate effect on the flight, but at best, it can lead to an early and expensive overhaul of the equipment.

- Books placed on the glare shield or pedestal: these fall off and may operate some switches or pushbuttons, such as a fuel lever being pushed off, or even deselect a radio frequency.

- Forgotten pens, cutlery (during meals) or clipboards: as small as they can be, they can get jammed in the controls typically the rudder pedals when they fall on the floor and move during flight.

Each one of the above incidents serves as an important reminder of the critical need to ensure that items are properly stowed and secured before AND during flight.

The culprits

“Prevention is essential and discipline in the cockpit is paramount”

Establishing an exhaustive list of all potential candidates that may interfere with the controls would be too long and ineffective. These items can include aviation related items such as portable GPS units, clipboards; non aviation related Portable Electronic Devices such as personal cell phones or laptops; and personal items such as clothing or carryon items.

Following are the most common objects that can be found unsecured or forgotten in a cockpit:

- iPad
- Laptop
- Cell phone
- Digital camera
- Spectacles and sunglasses
- Scattered papers
- Pen
- Clipboards
- Meal tray
- Coffee or any beverage cup
- Pocket calculator
- Lighter

This list could be longer, but it gives an idea of the kind of common equipment likely to create hazards when left loose in a cockpit.

The aircraft cockpit ergonomics are designed to be as robust as possible against these kind of threats. Where relevant, Airbus has developed modifi- cations to prevent the ingestion of foreign objects into the controls. The flap lever mechanism for instance is protected by a brush covering the lever slot, thus efficiently preventing foreign object ingress.

However, even a perfectly welldesigned cockpit can never be fully protected against the malicious behaviour of unsecured objects. For this reason, prevention is essential and discipline in the cockpit is paramount.

Everything, And Everything In Its Place…

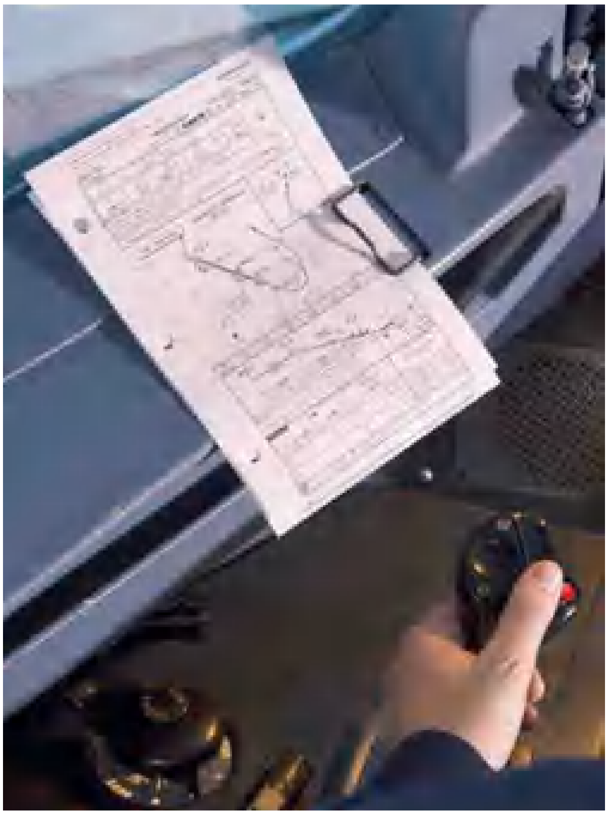
The 2014 event could have resulted in far worse consequences, had the aircraft been at a lower altitude. This was a strong reminder to the flight crew that they should never underestimate the potential for harm of everyday life objects, when left unsecured!

In fact, the solution against such events lies in one word: discipline.

To help efficiently curb the number of operational incidents involving a loose item in the cockpit, pilots need to be vigilant and ordered.

First, items that are brought into a cockpit must be stowed in their dedicated compartment:

- Cups in the cup holders
- Headsets not in use, on the hook stowage
- Books and paper, if any, in the lateral stowage
- Trash in the waste bin in the lateral console
- Meal trays on the floor behind the flight crew. The flight attendants should collect the meal trays as soon as possible.



- Personal equipment properly secured in the various stowage areas. The Pilot Pocket in particular, is the place to stow valuable items such as a portable GPS or cell phone.

- Flight bags should be kept closed after obtaining whatever is necessary.

Then, we encourage flight crews to incorporate the following simple checks in their preflight actions in order to ensure their working environment is well secured for a flight:

- Inspect the cockpit for forgotten or misplaced items before takeoff and ensure all are properly secured and isolated from other equipment in the cockpit. This also helps assure their availability throughout the flight.

- Make sure all your personal items such as hats and jackets, iPads or luggage are secured.

- If necessary, remind jump seat riders not to create distractions and to adopt the same measures and same discipline against unsecured items.

And maintain this attitude and level of alertness prior to AND during flight, putting a particular emphasis on the preparation for the approach phase during the approach briefing prior to descent.

Loose items in a cockpit environment are not welcome: they can too easily drive a crew into a hazardous, and yet easily preventable, operational situation.

To efficiently curb the number of incidents related to unsecured or forgotten items, pilots need to be vigilant and adopt a clean and tidy cockpit philosophy from preflight through to landing and arrival at the gate.

When entering the cockpit, ask yourself these questions: is all of the luggage secure? How about my own flight bag and my iPad?

And remember: a place for everything, and everything in its place…

Reprinted from Airbus Safety First publication.

Dubai

United Arab Emirates

“The Future of Aircraft Accident Investigation”

The annual seminar and tutorials of the International Society of Air Safety Investigators will take place at the Intercontinental Hotel, Festival City, Dubai,

from

29 October to 1 November 2018

For more information about the ISASI Seminar 2018, please visit:

http://isasiannualseminar.com/

Joshua Migdal

Senior Air Safety Investigator
Delta Air Lines

Investigating an MD80-Runway Excursion

On March 5, 2015, a Boeing MD88, N909DL, operating as Flight 1086, departed Atlanta, Georgia (ATL), bound for New York, New York (LGA). The flight crew was aware of the winter storm that was impacting the New York area. During cruise, the flight crew discussed the weather, runway conditions, landing distances, and diversions. As the flight approached New York airspace, the flight crew was assigned holding due to runway clearing operations. Subsequently, the flightcrew members were informed of good pilot-reported braking actions, and they were cleared for the instrument landing system (ILS) approach to Runway 13. At 300 feet, the flight crew observed a completely snow-covered runway, which was not anticipated. The approach was continued, and the aircraft touched down approximately 600 feet beyond the runway threshold.

Upon touchdown, the first officer manually deployed the speedbrakes, and the captain activated the thrust reversers. As the nose landing gear touched down, the captain applied reverse thrust, and the aircraft began to slide to the left. At that time, the flight crew did not observe a normal deceleration, and the aircraft continued in a leftward movement. The first officer then informed the captain to discontinue the use of reverse thrust. The captain deactivated the reverse thrust, and the aircraft continued to slide to the left despite the captain's right steering inputs. Subsequently, the aircraft departed the runway surface at approximately 80 knots.

After departing the runway surface, the aircraft traveled across a grassy area before striking a seawall. The aircraft traveled parallel to the seawall, impacting the airport perimeter fence for approximately 1,000 feet before turning sharply to the left. The aircraft stopped with the nose suspended over Flushing Bay and fuel leaking from the left wing (see Figure 1). Subsequently, aircraft rescue and firefighting (ARFF) personnel arrived, and an evacuation was initiated.

The aircraft sustained substantial damage, and 29 of the 131 passengers and crew on board received minor injuries. The event was classified by the National Transportation Safety Board (NTSB) as a damage accident. This article outlines the investigation's findings and reviews the safety actions implemented to prevent future events.

Figure 1. Photograph of the aircraft's final resting location (NTSB photo)

Investigation overview

Delta Air Lines and the NTSB launched investigative go-team members to LGA and ATL. Additional party members included representatives from the Federal Aviation Administration (FAA), Boeing, the Air Line Pilots Association, International (ALPA), and the Port Authority of New York and New Jersey. Investigation team members gathered in New York, Atlanta, and Washington, D.C., to begin the process of reconstructing the sequence of events that contributed to the accident. Focus areas included operations/human performance, vehicle performance (recorder data), and airport operations.

Operations

To better determine the runway conditions, the flight crew utilized the automatic weather updates through the aircraft communications addressing and reporting system (ACARS) and requested braking action reports. Enroute, flightcrew members noted that they were initially unable to obtain braking action information. Their interpretation of the runway's conditions was based on Notice to Airmen (NOTAM) reports that the runways were wet, sanded, and chemically treated. Even with these conditions, the flight crew identified a requirement for braking action of good or better to land by reviewing the MD-88 operational landing distance charts.

During descent, the flight crew prepared to enter holding due to runway clearing operations. As the crewmembers continued the descent, the air traffic controller informed them that the runway was open. Subsequently, poor braking action was reported, and a preceding aircraft initiated a diversion. A short time later, an Airbus aircraft reported good braking action, and the preceding aircraft elected to land at LGA. Based on reports of good braking action, the flight crew elected to land.

On final approach, the flight crew observed the approach lighting at approximately 400 feet and the runway at approximately 300 feet. The flightcrew members noted that the runway was snow-covered, which was not what they anticipated, based on previously received field condition reports. The flight crew elected to continue the approach based on the reports of good braking action.

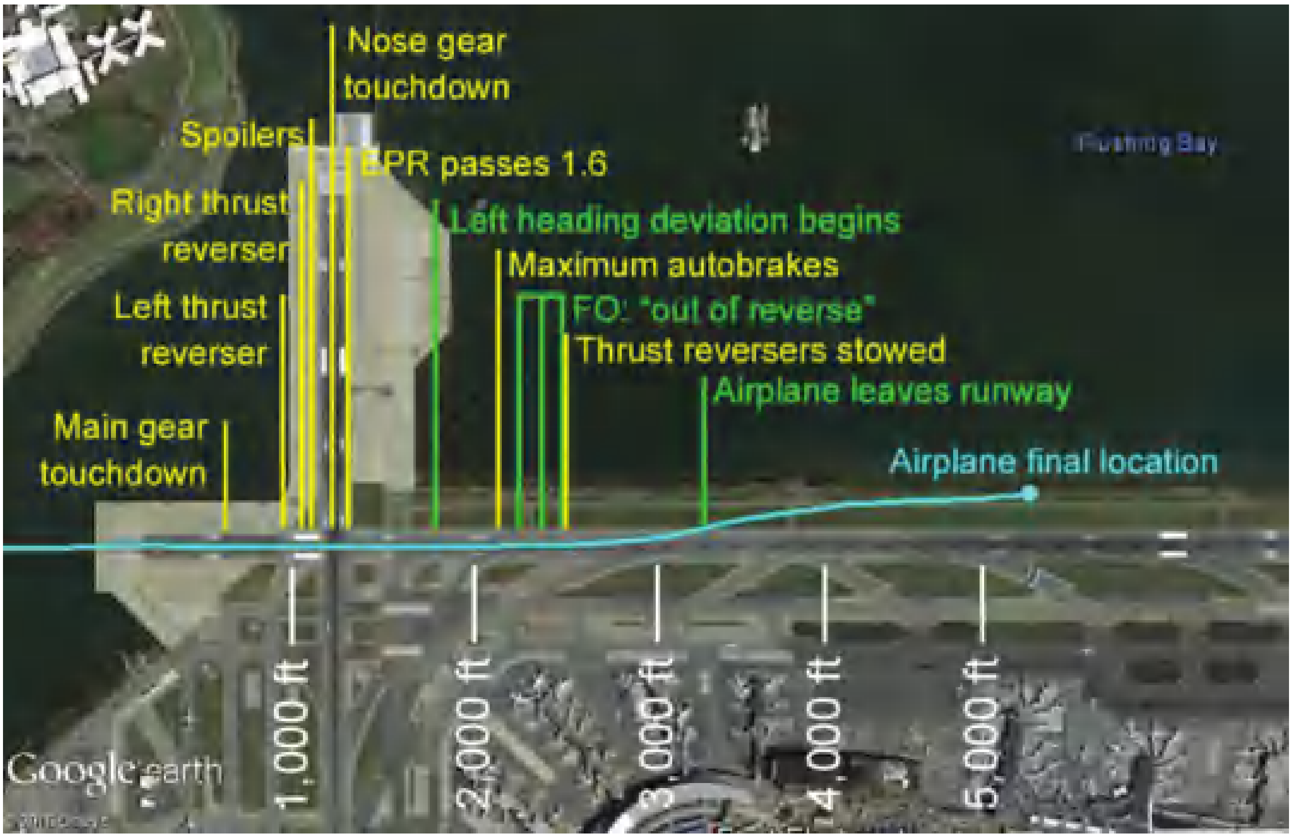


Figure 2. Aircraft ground path (NTSB photo)

Aircraft performance

A performance study indicated that the aircraft touched down at 133 knots, approximately 600 feet from the runway threshold. Approximately 1,600 feet from the runway threshold, a left-yawing moment began, and the flight crew applied right rudder. During that time, the reverse thrust engine pressure ratio (EPR) exceeded 2.0 and 1.9 for the left and right engines, respectively. Subsequently, the thrust reversers were stowed, and manual braking was applied. The aircraft exited the paved surface 3,200 feet from the runway threshold, approximately 14 seconds after main landing gear touchdown (see Figure 2).

As noted in the performance study, test data indicated that the rudder on the DC9-80 series aircraft has limited directional authority at airspeeds below 146 knots with reverse thrust EPR values above 1.6. Additionally, at airspeeds below 108 knots, the rudder has limited directional authority with reverse thrust EPR values above 1.3. The high EPR values resulted in rudder blanking and the rudder's reduced effectiveness during the left yaw and heading deviation. The application of manual braking and nose wheel steering contributed to reducing the left yaw but were insufficient to correct the aircraft's path with the rudder blanked. The NTSB investigation was unable to determine the circumstances that contributed to the heading deviation.

Following the accident, data from the quick access recorder (QAR) from the accident aircraft and the prior landing aircraft, Flight 1526, an MD-88, were analyzed. The analysis revealed that EPR values above 1.6 were common, including during times of reported precipitation (see Figure 3). Investigators noted that none of the 80 recorded landings exhibited a significant deviation in heading or resulted in a runway excursion. Additionally, of all of the landings analyzed, the accident landing had the highest recorded EPR, as well as the shortest time to rise from 1.3 EPR to 1.6 EPR. The data review demonstrates that aircraft routinely experience reverse thrust above 1.3 EPR without degradation of lateral control; this indicates that the conditions of the runway at the time of touchdown likely contributed to the loss of directional control and inability to recover.

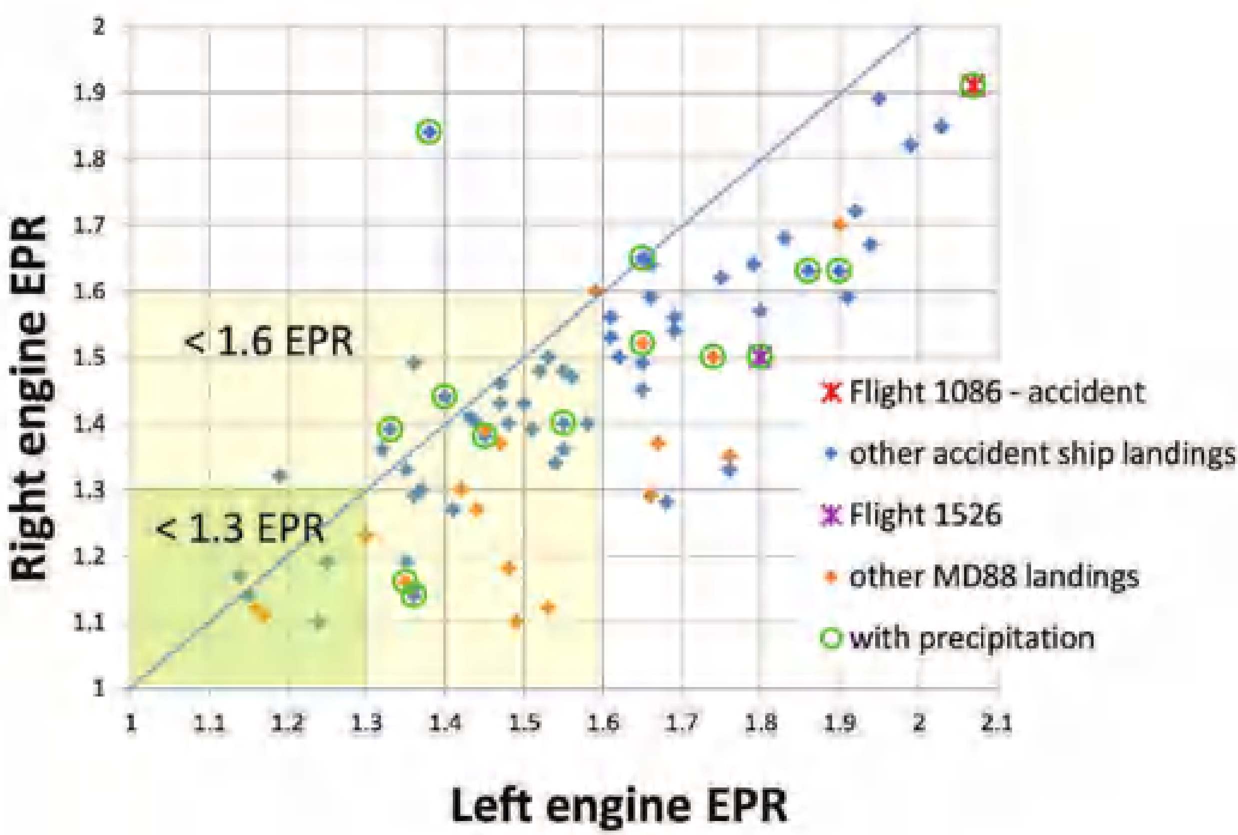


Figure 3. Scatterplot graph of recorded QAR data (NTSB photo)

Flight recorder data were used to estimate the wheel braking coefficients for the accident aircraft and the prior landing aircraft. The estimated wheel braking coefficient was determined to be approximately 0.16 or better, which is less than good. With the exception of one prior landing that reported braking action as medium at touchdown and poor at rollout, the other landing aircraft reported good braking action. This demonstrates the subjectivity of pilot braking action reports as it relates to actual runway friction assessments. Had the flightcrew members been provided with a more accurate runway condition assessment, they would have diverted, as discussed during approach, due to the need for good or better braking action.

Airport operations

The investigation produced a timeline of events that revealed the runway was last cleared at 1035 EST and that the last NOTAM was issued at 0903 EST. The investigation uncovered that the 0738 EST NOTAM indicated that the runway had been chemically treated, even though it had not been. The LGA operations manager stated in an interview that NOTAMs will only be issued when conditions change, and a new NOTAM will not be issued after clearing operations, if the runway conditions are comparable to the conditions previously reported. This practice is not in accordance with FAA Advisory Circular (AC) 150/5200-30C.

Approximately 20 minutes after the accident, a request for a postevent friction assessment was made but not accomplished by the Port Authority. Following the accident, it was requested that the Port Authority share friction testing results (Mu) during times of active precipitation. This request was denied by the Port Authority.

In an interview with LGA's chief operations supervisor, it was noted that LGA had CFME vehicles that were not used during snow-removal operations. In regard to runway assessments and clearing, the NTSB referenced a Jan. 20, 2016, e-mail from the LGA aeronautical operations manager that states LGA does not allow "snow to collect on the runway past the point of 'thin' or to the point [they] need to measure it. It is a visual assessment from the teams constantly monitoring the conditions on the field." With regard to specific "triggers" that require the beginning of plowing operations, he stated that the triggers were "braking action reports, visual inspection, weather forecast data, [and] surface temps."

According to FAA AC 150/5200-30C, "Runway condition reports must be updated any time a change to the runway surface condition occurs." The AC notes that a change includes the application of chemicals or sand as well as runway clearing operations. Additionally, the AC states, "Airport operators should not allow airplane operations on runways after such activities until a new runway condition report is issued reflecting the current surface condition(s) of affected runways."

Oversight

The FAA airport certification inspector, who completed the annual airport inspection at LGA for the previous three years, was asked about information in AC 150/5200-30C. In response to a question noting that airports are required to comply with the AC, the inspector stated, "An advisory circular is just that, advisory." However, the Application section of the AC states: "Certificated airports are required to follow the requirements of Paragraphs 5–6 [Requirements for Runway Closures] and 5–7 [Continuous Monitoring] as of the effective date of this AC. In addition, all certificated airports must submit revised snow and ice control plans to the FAA no later than April 30, 2009, for approval. At that time, certificated airports will be required to comply with the remaining portions of this AC. The AC is advisory for noncertificated airports." The inspector stated that in his personal opinion, the use of runway friction-measuring equipment provides a useful tool for runway trending and that he was unaware that LGA does not use runway friction-measuring devices during winter operations. The inspector noted that he was aware of an agreement with the air traffic control tower and the airport that states that the Port Authority "may" conduct runway friction assessments when necessary.

Probable cause

The NTSB determined that the probable cause of this accident was "the captain's inability to maintain directional control of the airplane due to his application of excessive reverse thrust, which degraded the effectiveness of the rudder in controlling the airplane's heading." The NTSB noted, "Contributing to the accident were the captain's (1) situational stress resulting from his concern about stopping performance and (2) attentional limitations due to the high workload during the landing, which prevented him from immediately recognizing the use of excessive reverse thrust."

Similar event

Due to the design of the thrust reversers on the DC-9-80 series aircraft, the fleet has experienced several accidents where rudder blanking was a factor. One such event is an accident involving a McDonnell Douglas Corporation DC-9-80 in Yuma, Arizona, on June 19, 1980. In this event, the aircraft departed the right side of the runway while attempting a simulated hydraulic system inoperative landing. The NTSB determined the probable cause of the accident to be the "inadequate procedures established for certification test flight, and the pilot's mismanagement of thrust following the initial loss of directional control." During the investigation, the NTSB conducted flight tests and high-speed taxis at 90 and 140 knots to determine directional controllability with various levels of forward and reverse thrust. The NTSB stated, "The flight test data showed that at 1.6 EPR symmetrical reverse thrust and at 109 KIAS the powered rudder control effectiveness as zero." (See Table 1.)

Engine Thrust Setting	Maximum Rudder Effectiveness Available (percent)*
Forward idle	100
Reverse idle	65
1.3 EPR (Reverse)	25
1.6 EPR (Reverse)	minimal

*Rudder effectiveness also decreases with decreasing speed

Table 1. DC-9-80 Rudder Effectiveness Availability (NTSB AAR81-16)

The investigation resulted in the NTSB issuing 11 recommendations, which included a recommendation to incorporate DC-9-80 rudder blanking and rudder effectiveness information into training manuals and curriculums. This recommendation was closed with acceptable action in 1984. Although rudder blanking information has been incorporated into training manuals and curriculums, the detailed rudder effectiveness availability information identified in the Yuma, Arizona, investigation has not been incorporated.

Incident prevention

Boeing

Following the 1980 accident, rudder blanking information was disseminated via several methods, including a Feb. 15, 1996, Boeing All Operators Letter. This letter discussed MD-80 landing characteristics on wet or slippery runways. The letter noted that the reverse thrust buckets were canted slightly to reduce foreign object damage (FOD). The angle of the thrust reversers resulted in a disruption of airflow across the rudder when a reverse thrust setting of above approximately 1.3 EPR is used.

In an effort to develop a technological solution to prevent excessive reverse thrust, Boeing issued Service Bulletin MD80-78-068 on May 29, 1996. The bulletin implemented an improved thrust reverser cam support assembly. The new assembly provided the flight crew with a throttle lever detent for 1.3 EPR. Due to reports of excessive EPR split with the new assembly, the bulletin was rescinded by Service Bulletin MD80-78-070 on May 29, 1997.

On Nov. 5, 2002, Boeing issued a Flight Operations Bulletin to all MD-80 operators stating that 1.3 EPR should be the maximum reverse thrust power under wet or slippery runway conditions.

Delta Air Lines

Following the accident in LGA, Delta conducted a Safety Management System (SMS) safety risk assessment (SRA) to review reverse thrust usage on the MD-88. After completion of the SRA, a decision was made to limit reverse thrust to 1.3 EPR (formerly 1.6) on dry runways. When landing on nondry runways, the flight crew initially selects idle reverse thrust, and after reverse-thrust symmetry is verified with the aircraft aligned with the runway track, flight crews may gradually increase reverse thrust to no greater than 1.3 EPR.

Delta is continuing its participation in two demonstration studies of aircraft-based technology that have the potential of becoming runway friction-assessment tools for next-generation contaminated runway guidance. One such tool is Aviation Safety Technologies' (AST) SAFELAND system, which uses the aircraft's systems to report "true aircraft runway surface characteristics, true braking friction, cornering friction, and tire and brake wear." The system does this by monitoring and measuring multiple aircraft parameters that includes spoilers, flaps, hydraulic and mechanical braking, accelerometers, and atmospheric conditions. The SAFELAND system has been placed on Delta's A319/320 and B-737700/800/900ER fleets. Delta is also participating with Zodiac Aerospace to test its Braking Action Safety System (BASS).

Through previous internal investigations into runway excursion events on all fleets, during winter conditions and during several visits with airport management at northern-tier airports, a Special Winter Operations Airport (SWOA) program was established in 2005. Flight Safety introduced the SWOA program to mitigate the risks associated with the difficulty in standardizing runway treatment, clearing, and friction-testing, as well as addressing environmental factors, which increase an aircraft's risk of runway excursion during winter conditions.

Additionally, the program was designed to assist airports in upgrading snow plans, equipment, and facilities. SWOA airports are identified through a matrix that accounts for several elements, including incident history, friction-testing equipment used, vertical guidance availability, runway lighting, runway length, field elevation, and surrounding terrain. Airports that have been identified through the SWOA program will be scheduled for a biannual visit to foster conversations to enact changes to improve safety. SWOA airports are also subject to operating restrictions when frozen precipitation is falling and accumulating or the runway is contaminated with frozen precipitation.

Industry

Following a 2005 runway excursion at Midway Airport in Chicago, Illinois, the FAA formed the Takeoff and Landing Performance Assessment (TALPA) Aviation Rulemaking Committee (ARC) to reduce the risk of runway excursions. The committee developed recommendations for airport authorities to determine runway conditions and for aircraft operators to determine required stopping distances. The FAA used the TALPA ARC's recommendations to develop new methodologies that were implemented on Oct. 1, 2016.

As a part of the new methodologies, the FAA has implemented the use of a Runway Condition Assessment Matrix (RCAM) that will be used to determine a numerical Runway Condition Code (RwyCC). The use of the RwyCC will replace runway friction assessments (Mu) when conducting landing distance assessments. Additional implemented methodologies will align processes with International Civil Aviation Organization (ICAO) standards.

The ICAO Friction Task Force has also developed runway assessment and reporting processes based on the TALPA ARC recommendations. These processes also use runway conditions that are coded into a matrix to provide runway performance information.

Conclusion

The flightcrew members identified the need for a braking action of good or better in order to land, which they received from pilot reports from prior landing aircraft. In addition to the pilot reports, the LGA NOTAMs led the flight crew to anticipate a runway condition that did not exist. The actual runway condition was snow-covered and not chemically treated with an estimated braking coefficient that was less than good at 0.16 or better. After touchdown, the aircraft experienced a left yaw and due to excessive reverse thrust above 1.3, the flight crew was unable to recover before departing the paved surface and striking a sea wall.

Although the DC-9-80 series aircraft have unique landing characteristics on wet or slippery runways and are more susceptible to rudder blanking, the industry continues to experience excursions on all types of aircraft. With new aircraft becoming ever more sophisticated, the industry has an opportunity to develop reliable and repeatable methods to generate braking action reports that do not rely on the subjectivity of flight crews. As safety professionals, we must champion for standardization in airport procedures and objective methods of determining runway friction to mitigate the risk of future runway excursions on wet or slippery runways.

Author

Joshua Migdal is a senior air safety investigator with the Delta Air Lines Flight Safety Department. He received a Master of Science degree in safety science from Embry–Riddle Aeronautical University in Prescott, Arizona. As an investigator at Delta Air Lines, he is responsible for conducting internal incident investigations and functioning as an NTSB liaison and party coordinator. He holds an FAA commercial pilot and flight instructor certificate with an instrument rating and has flown fixed- and rotary-wing aircraft.

(Adapted with permission from the author's technical paper, Investigating an MD-80 Runway Excursion, presented during ISASI 2016 in Reykjavik, Iceland, October 18–20, 2016. The full text of this presentation can be found on ISASI's website at www.isasi.org/Library/technical-papers.aspx. This article is reprinted with permission from the ISASI Forum, January-March 2017.)

Dubai
United Arab Emirates
ISASI Seminar and Tutorials

"The Future of Aircraft Accident Investigation"

The annual seminar and tutorials of the International Society of Air Safety Investigators will take place at the Intercontinental Hotel, Festival City, Dubai, From

29 October to 1 November 2018

Attendees of the Seminar are encouraged to join one of the Tutorials on 29 October:

- Future Developments in Aircraft Accident Investigation
- Basic Failure Analysis- Failure Mode Identification at the Accident Site
- Military Aircraft Accident Investigation

For more information about The ISASI Seminar and Tutorials, please visit:
http://isasiannualseminar.com/

Patrick Chiles
Flight Safety Foundation

Thirteen Seconds

Figure 1 SpaceShipTwo   Credit Luke Colby

On the morning of Oct. 31, 2014, about 13 seconds after being released from its WhiteKnightTwo (WK2) launch vehicle, the suborbital spaceplane SpaceShipTwo (SS2) broke up in flight and struck the desert near Koehn Dry Lake, California, U.S., after its reentry device was unlocked by the copilot, causing inadvertent deployment at transonic speed. The pilot was severely injured but was able to descend to the ground by parachute, and the copilot was fatally injured. There were no injuries on the ground. The experimental spaceplane was destroyed, and the U.S. National Transportation Safety Board (NTSB) conducted its first investigation of a commercial spacecraft accident.

Premature unlocking of SpaceShipTwo's reentry system calls into question steps taken to mitigate human errors capable of causing in-flight breakup.

Designed by famed Scaled founder Burt Rutan and featured a unique reentry concept based on a feather system that temporarily rotates a flap assembly with twin tail booms that must be unlocked and extended upward from the normal flight position to a 60-degree angle relative to the vehicle's longitudinal axis (Figure 1) in a precisely timed sequence.

Though less problematic than reentry at orbital velocities, suborbital reentry carries similar risks of friction heating and loss of control, with design solutions that are at cross purposes with the overall need to minimize drag in other flight phases. The highly streamlined rocketship would have to be "unstreamlined" for reentry, maximizing drag to distribute heat while remaining stable. Rutan realized the ideal solution would be for the vehicle to assume a high-drag shape like a badminton shuttlecock, presenting a large surface area to the atmosphere while remaining inherently stable. On both SS1 and SS2, this was accomplished by hinging the twin stabilizer booms and flap assembly: The tail remains horizontal until leaving the atmosphere, then pivots to a nearly vertical attitude as the vehicle coasts through apogee (the highest point of the flight trajectory). During reentry, airflow over the feathered control surfaces forces the vehicle into a belly-first attitude. Scaled describes this as a "hands off" reentry, requiring little to no pilot input during this critical phase. Once safely in the atmosphere, the pilots would return the vehicle to a normal "unfeathered" configuration for the unpowered descent and landing.

SS1's success attracted the attention of the Virgin Group's founder and chairman, Richard Branson, who partnered with Scaled to create the world's first commercial spaceline, Virgin Galactic. The two companies formed a joint venture, The Spaceship Company, which would build the WK2 and SS2 vehicles for carrying passengers into space.

SS2 needed a more powerful rocket motor than SS1, but development of that motor put the program behind schedule and suffered its own tragedy. In 2007, the new motor's oxidizer tank exploded under pressure during a "cold flow" test. The accident destroyed the test stand, killing three engineers and injuring three others.1 Seven years later, the new motor was not a contributing factor in the SS2 accident, but the constantly evolving design led to aerodynamic changes that further slowed the vehicle's development. Being integrated within the airframe, the vehicle design could not be finalized until the motor's precise dimensions, mass-related properties and subsystems were established. As such, the Oct. 31 test marked the first powered flight of SS2 in over nine months.

Final Flight

Test objectives for the flight included a 38-second rocket burn to reach an apogee of 135,000 ft above mean sea level (MSL) and a maximum velocity of Mach 2, with deployment of the feather system for a planned reentry at 1.2 Mach and a gliding descent to a landing at Mojave Air and Space Port (KMHV). After a 0500 local time briefing with their chase airplane pilots and mission control engineers, the WK2/SS2 pilots began preflight inspections at 0730. The mated vehicles departed KMHV at 0919.

Approximately 40 minutes later, WK2 reached the targeted release altitude of Flight Level 460 (approximately 46,000 ft) as SS2's crew began pre-launch checklists. The "launch minus 10 minutes" checklist called for the copilot to confirm operation of the feather system locks, which included lock/unlock functions and status/warning indications on the multifunction display. No anomalies in the lock mechanisms or feather system extend-retract checks were detected.

It was well known among the team that, per procedures specified and practiced in a fixed-base simulator for this flight, the feather system could not be safely unlocked below 1.4 Mach due to the extreme aerodynamic forces that occur in the transonic range of velocities. Transonic generally is considered to be the region of high subsonic speeds at which localized airflow becomes supersonic around isolated areas of the airframe. This places increased aerodynamic and structural loads on the airframe due to compressibility effects (standing shock waves, etc.). It is often where maximum dynamic pressure occurs, which is why SS2 needed to be safely past Mach 1 before unlocking the feathers.

Moreover, the feather system had to be unlocked before reaching 1.8 Mach to enable reliable extension. Otherwise, procedures required the flight to be aborted because the controlled reentry made possible by the feather system would not be assured.

This left a narrow window of opportunity for the copilot to act, given SS2's rapid acceleration after release from WK2 and the high-workload environment, which was compounded by intense vibrations and control forces that could not be adequately reproduced in the simulator. Nor could the simulator generate realistic effects - discussed during SS2 pilot training - of mistimed unlocking leading

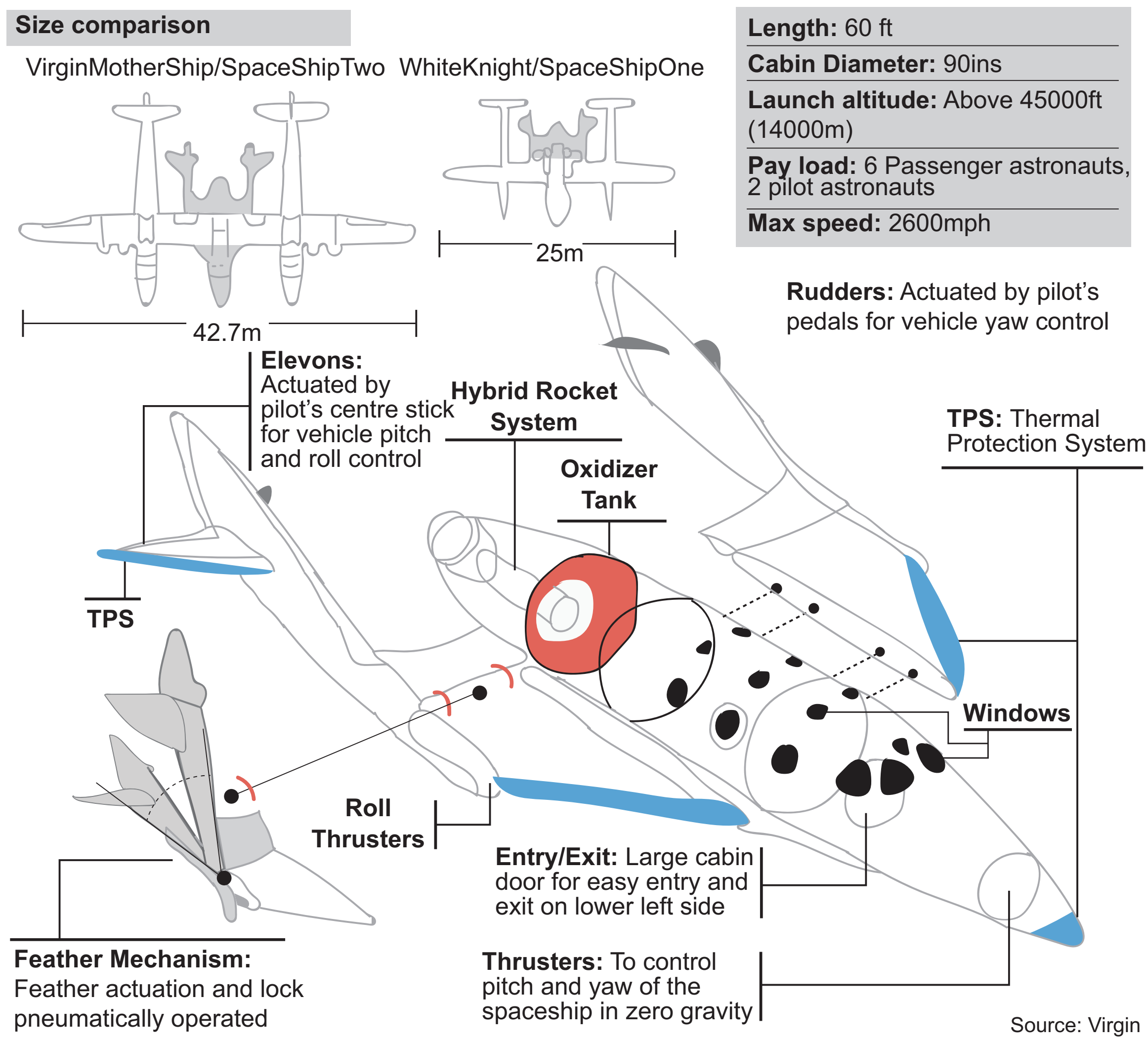


Figure 2

to uncommanded feather system deployment with aerodynamic vehicle breakup: If unlocked too soon in the simulator, there would be no directly observable consequence.

On the actual spaceship, once unlocked, all of the aerodynamic and inertial forces were borne by the feather system's two lock actuators and four feather flap hinges. But, SS2 being a developmental program, the critical speed limits within procedures and checklists were subject to change based on specific test conditions.

The greater fear within the program leadership was that the feather system would fail to retract after reentry and render the vehicle uncontrollable, rather than a pilot making an unrecoverable error in performing related highly practiced procedures, NTSB said. Perhaps belying Scaled's successful heritage in research and development, the program's focus on engineering a spacecraft that performed flawlessly led to assuming existence of a common "tribal knowledge" mentality: "The SS2 accident pilot knew that the feather was not to be unlocked before 1.4 Mach but could not remember if that information was conveyed in a design review or during informal discussions," according to the NTSB's final report. "He stated that the requirement for feather locks [to remain locked] in the transonic region 'came up many times' and believed that this information was 'common knowledge.' Other Scaled and Virgin Galactic pilots stated they were also aware of the requirement not to unlock the feather during the transonic region. Scaled's vice president/general manager stated that the company had not considered the possibility that a pilot would unlock the feather before 1.4 Mach."

NTSB determined that Scaled operated on the assumption that their test pilots would simply not make such a mistake. "Although some evidence indicated that SS2 pilots were made aware that the feather should not be unlocked before the designated Mach speed, there was insufficient evidence to determine whether the pilots fully understood the potential consequences of unlocking the feather early," the NTSB report said. "No warning, caution or limitation in the SS2 POH [pilot operating handbook] specified the risk of unlocking the feather before 1.4 Mach."

NTSB determined that the probable cause of the accident was Scaled's "failure to consider and protect against the possibility that a single human error could result in a catastrophic hazard to the SS2 vehicle. This failure set the stage for the copilot's premature unlocking of the feather system as a result of time pressure and vibration, and loads that he had not recently experienced, which led to the uncommanded feather extension and subsequent aerodynamic overload and inflight breakup of the vehicle."

Crew actions

In analyzing the copilot's actions, the NTSB found that, "Because of the dynamic nature of the boost phase, the copilot memorized his three tasks to be accomplished during that phase: calling out 0.8 Mach, calling out the pitch trim position in degrees as the pilot trimmed the horizontal stabilizers, and unlocking the feather at 1.4 Mach. In addition to recalling these tasks from memory, each of the tasks needed to be accomplished in a limited time frame. ... Because of the importance of unlocking the feather before 1.8 Mach, the copilot might have been anxious to unlock the feather to avoid aborting the flight Thus, time pressure was likely a stressor that contributed to the copilot incorrectly recalling the sequence of his tasks and unlocking the feather prematurely."

At this point in the accident sequence, the vehicle was only at 0.82 Mach. NTSB simulator tests indicated SS2 would not have reached 1.4 Mach for another 13 seconds. As noted, other contributing factors amplified the copilot's workload; in particular, vibration and high acceleration, though it is notable that the surviving pilot reported that the new nylon fuel grain burned smoother than the original rubber-based propellant compound. Within two seconds (between the 0.8 Mach callout and unlocking the feather), axial acceleration had jumped from 1 g to 2.3 g (2.3 times standard gravitational acceleration).

Safety Culture

The copilot's actions immediately before the in-flight breakup proved to be unexplainable for NTSB but did not occur in a vacuum. The report was critical of the safety cultures within both Scaled and the FAA Office of Commercial Space Transportation (FAA/AST). The report pointed to the proliferation of safety management systems (SMS) and crew resource management (CRM) within commercial aviation as offering mitigating solutions to risk factors noted.

One of the fundamental concepts of SMS is a thorough description of operational processes, so there can be no confusion as to what actions are expected in a particular situation. "Say what you do, do what you say" is a difficult hurdle for an organization that is not accustomed to documenting its processes. Yet, the NTSB determined that "Scaled's accomplishments led to complacency regarding human factors. … Management, test pilots and engineers did not fully consider the risk of human error because of the flawed assumption that test pilots would operate the vehicle correctly during every flight. Also, Scaled had not informed FAA/AST personnel that early unlocking of the feather could be catastrophic, which provided further evidence of Scaled's expectation that a pilot would perform as trained."

That is not to say that Scaled, when developing its own systems safety analysis (SSA), did not consider other accepted industry practices such as commercial aircraft certification standards, in addition to FAA Advisory Circular (AC) 437.55-1, *Hazard Analysis for the Launch or Reentry of a Reusable Suborbital Rocket Under an Experimental Permit.* The AC addresses protection of people on the ground in the event of a launch vehicle failure and stipulates that potential human error must be considered during the hazard analysis. This specifically included operating certain flight controls at the wrong time. Scaled told NTSB investigators they believed their analysis fully captured these potential risk conditions.

Given its long history in research and development and with its test pilots, it is understandable why Scaled's SS2 team might assume that their pilots would correctly follow procedures every time, the report said. The report also questioned whether SS2, given the accident investigation findings, was being adequately developed for future operation by pilots who may not have flight test experience. Specifically, before the accident flight, Scaled's engineers had been focused on the potential mechanical causes of an uncommanded feather system extension: "Scaled's analysis showed that the probability of failure for the hazard involving uncommanded feather operation during the boost phase met the 'extremely remote' criteria in [U.S. Federal Aviation Regulations Part] 437.55(a) and Scaled's quantitative requirement of 1 x 10-6 [that is, one failure in 1 million flights]. As a result, Scaled determined that the feather system design was adequate and that no mitigations were needed to ensure that the feather would remain retracted during the boost phase."

NTSB examination of Scaled's analysis revealed that the company had considered human error only in the context of response to external factors - specifically, that a pilot may "incorrectly respond while attempting to mitigate another failure. As a result, the SSA did not account for single flight crew tasks that, if performed incorrectly or at the wrong time, could result in a catastrophic hazard. … Specifically, Scaled did not account for the possibility that a pilot might unlock the feather prematurely."

While several of Scaled's engineers and at least one pilot stated they had taken university courses in human factors, there was no human factors expert on staff. This lack of expertise would explain overreliance on training to reduce the risk of pilot error in the SS2 operating environment, according to the report.

NTSB cited the U.S. Defense Department's system safety "design order of precedence," in which the greatest potential for improvements occurs in the following order: design enhancements, engineered features or devices, warning devices, and training and procedures. For SS2, the "last choice," or least effective mitigation strategy, was the one that was relied on to mitigate the probable cause of this accident.

Safety Recommendations to FAA

FAA/AST was found to have created administrative "filters" within its experimental flight permit process that stifled certain technical staff efforts to thoroughly analyze SS2's risks. The NTSB report noted that the FAA -while tasked with overseeing commercial airline SMS - did not have its own SMS in place during SS2's pre-application and permit evaluation processes. Rather than taking a team project-management approach, FAA/AST had one individual in its Operations Integration Division act as Scaled's main point of contact. NTSB said that FAA leadership believed this would remove any undue burdens on the applicant, and as a result, this person relayed all information from Scaled to the Licensing and Evaluation division's permit team.

Predictably, this became a choke point for communication about risks. Several FAA technical staff told NTSB that draft technical questions proposed for Scaled engineers - if not specifically related to public safety - were "filtered" (i.e., deleted from those actually sent). One staff member said that this filtering process resulted in information that was "so washed out, it's not even what we asked for in the beginning," according to the report.

One experienced Space Shuttle program veteran expressed frustration about FAA/AST managers and staff members, who, with limited knowledge of spaceflight, were reviewing and significantly editing the technical questions posed to Scaled during the permit process. NTSB found that this lack of direct communication among technical experts, political pressure to approve experimental permits within a 120-day review period and a lack of clarity between public safety and mission assurance prevented a thorough evaluation of SS2's initial and renewed experimental flight permit applications.

No one yet knows what the ideal designs and pilot training will be for a passenger spacecraft, and there are as many different design solutions as there are designers. In contrast, the commercial airline industry has been refining equipment, systems for flight operations and training for decades, as have state regulatory bodies.

Virgin Galactic has since taken over the SS2 flight test program while working with Scaled to design an electromechanical inhibitor into the feather lock system for all future vehicles. Employing pilots with extensive flight test experience, including one former astronaut, Virgin is also reported to be leveraging the parent airline's experience in safety management to refine the techniques for safely piloting the future spacecraft in regular service.

After leading the investigation into the U.S. National Aeronautics and Space Administration's (NASA's) fatal Apollo 1 fire2, astronaut Frank Borman said that the root cause was a "failure to imagine." In 1968, long duration human spaceflight was in some ways more mature than commercial suborbital spaceflight is today. By adopting CRM and SMS principles, these emerging "spacelines" can hope to make this new frontier feel like something less than "rocket science."

This article is based on NTSB Report AAR-15/02, "In-Flight Breakup During Test Flight; Scaled Composites SpaceShipTwo, N339SS; Near Koehn Dry Lake, California; October 31, 2014." July 28, 2015. Available at <www.ntsb.gov>.

Reprinted with kind permission of Flight Safety Foundation Aerosafety publication.

The Author

Patrick Chiles was a member of Flight Safety Foundation's Business Advisory Committee from 2000 to 2015. Outside his work as an aircraft dispatcher and safety manager, he writes about aerospace topics and is involved in amateur/high power rocketry. His novels, Perigee and Farside, are set in the world of commercial spaceflight.

Notes

1. "Test Site Explosion Kills Three," Tami Abdollah and Stuart Silverstein, Los Angeles Times, July 27, 2007.

2. On. Jan. 27, 1967, three U.S. astronauts were killed when a flash fire occurred in the command module during a launch pad test of the Apollo/Saturn space vehicle being prepared for the first piloted flight, the AS-204 mission. Jerome F. Lederer, founder of Flight Safety Foundation, that year retired from the Foundation and during 1967–1972 established and led NASA's Office of Manned Space Flight Safety.

الهيئة العامة للطيران المدني
GENERAL CIVIL AVIATION AUTHORITY

United Arab Emirates

VOLUNTARY REPORTING SYSTEM (VORSY)

REPORT to improve aviation safety

To send a report, please visit: www.gcaa.gov.ae/en/vorsy/pages/vorsy_eform.aspx
or use GCAA SAMAE mobile application

SAMAE سماي

- Scan this QR code to download GCAA SAMAE Application
- Refer to CAAP 57 - Voluntary Reporting System on GCAA website
- Communicate with a VORSY administrator: vorsy@gcaa.gov.ae

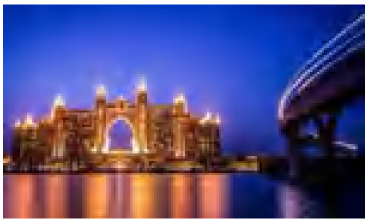
@GCAA_UAE FACEBOOK.COM/GCAAUAE GCAA_UAE GCAA.GOV.AE

ISASI Seminar 2018
29 October - 1 November

Companion Program

During the ISASI Seminar there will be a Companion Program which will include 2 days of touring, breakfast each morning and all the social events. Companions can attend a Welcome Reception on Monday night, Tuesday Night Dinner Cruise and the President›s Reception & Awards Banquet on Wednesday Evening. Lunch will be included during the tours on both days. More details are available at http://isasiannualseminar.com/

Day 1 Tuesday



Starting at 10:00

Pickup from hotel

First Location:
Etihad Museum

Second Location:
Atlantis the Palm

Third Location:
Burj Al Arab

Fourth Location:
Burj Khalifa

Day 2 Wednesday

Starting at 10:00

Pickup from hotel

First Location:
Al Fahidi Museum

Second Location:
Abra Ride across The Creek

Third Location:
Gold & Spice Souq

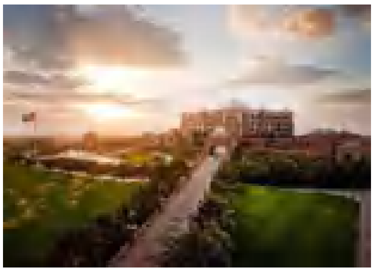
Fourth Location:
Dubai Frame

Friday Tour- 2nd November

To provide you with an opportunity to see Abu Dhabi, the capital of the United Arab Emirates, before you return home, we have planned a very pleasant and interesting Tour on November 2.

Sheikh Zayed Grand Mosque

The Louvre, Abu Dhabi



Emirates Palace