focus

ON COMMERCIAL AVIATION SAFETY

WINTER 2001/2

Concorde Flys Again!

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contents

Front Cover: *Concorde Flys Again following protracted grounding after the Air France Concorde accident at Charles de Gaulle. Photographed by Adrian Meredith Photography.*

Loading Errors

In recent months there has been a noticeable increase in loading errors reported through the Mandatory Occurrence Reporting (MOR) scheme. This type of event has the potential for disaster.

It may be argued that it is the operator's responsibility to ensure that the ground handling agent does the task of loading the aircraft correctly and ultimately it is the Captain's responsibility to check the load sheet for accuracy.

In terms of JAR-OPS the operator is required to audit its suppliers to ensure that they are doing the task according to the correct procedure and to make sure that their staff are properly trained with particular emphasis on safety. I am led to believe that the operators carry out these audits to the best of their ability, but because of the number of destinations some operators have, it is impossible to do this frequently enough to be absolutely sure that the loading task is carried out correctly on every occasion.

The aircraft Captain is the final check in the system. If, however, the load-sheet presented to him is correct but the way the load is positioned on the aircraft is incorrect he has no way of knowing. This is particularly the case on aircraft where it is physically impossible to enter the hold when loaded.

So who is responsible for such loading errors? Is it the Captain who checks the load-sheet but has no way of checking the load in situ? Is it the ground handling agent for failing to properly supervise and check the loading? Or is it the airline for failing to pick up such errors during their periodic audits? Could the regulator be blamed for introducing regulation that does not work adequately?

It could probably be argued that none of the above could be held responsible. They have after all done everything that is expected of them.

What could the consequences of taking an incorrectly loaded aircraft into the air be?

Consider the following case. You are the Captain of an aircraft which departs the ramp having checked the load-sheet. You set the trim and start the take-off run. At the point of rotation you find the aircraft nose heavy and you trim the pressure off the controls getting airborne at a speed somewhat faster than you would expect. Once safely airborne you consider the cause of the additional rearward trim required for take-off. You check the load-sheet and find once again that it appears correct. What would you do next?

Let us hope that you never find yourself in this situation. In order to ensure that you do not, perhaps now is a good time to consider the following questions and take appropriate action.

- Does your organisation have procedures for slow speed handling checks?
- Does your organisation have procedures for landing with a load out of limits?
- Does your organisation have procedures for unloading an aircraft suspected of having a loading error in order to ensure that the problem can be fully investigated?

The EU, in its quest to create freedom of competition, has not helped in the area of ground handling. We need better training and better control on the ramp rather than allowing ramp operators with little or no experience to operate freely and create difficulties in an already hazardous environment.

It is interesting to note that air operators pay large sums of money to airports and handling agents for their services and yet it is the air operators who remain responsible for the safety on the ramp over which they have very little control. Airport operators permit access to the ramp of selected ramp handling agents. They also have the ability to terminate such access. They are also best placed to frequently monitor and audit these service providers. Logic would seem to dictate that airport operators would be in a better position to ensure that the ramp handling agents are providing a safe and effective service.

The present system does not seem to be conducive to improving safety. If we are to reduce the number of loading errors and so improve safety then the allocation of responsibility for the ramp activities will need to be revised. The status quo does not appear to be having the desired effect.

Safety after the events of 11th September 2001

by Capt. Tom Croke

On the 11 September 2001 the entire world of aviation changed irrevocably with the terrible events of New York, Washington and Pennsylvania. On behalf of the United Kingdom Flight Safety Committee I would like to extend our heartfelt sympathies to all those who have been touched, directly or indirectly, by those tragic events. Of course we feel a particular affinity with the crew and passengers on the hijacked aircraft, but our feelings of association and compassion are equally extended to all those innocent people affected by these horrifying events.

The reaction to those terrible events reflects the initial confusion that we all felt. Many extreme responses were proffered in the search for "instant" solutions. As emotions subsided more rational suggestions were debated. The processes, which the aviation industry has developed over decades, have been turned on their heads in the urgency to find an "instant" solution to mitigate these latest threats to aviation security. Most have required the suspension of the normally considered, cautious and usually protracted procedures synonymous with the aviation industry. Many airlines face the prospect of the undoing of Crew Resource Management (CRM) culture, which they have spent years building, with the potential consequential effects on aviation safety. Now new processes must be devised, implemented and inculcated in all our flight and cabin crew. Each new security countermeasure it seems will bring fresh challenges which all aviation safety personnel must address in order to ensure that the safety record is not compromised.

While the immediate after effects of September 11 have been largely on the security front the lack of confidence of the travelling public in the aviation industry has translated into the greatest downturn in business that the industry has ever seen. The difficulties that Sabena and Swissair experienced are but the tip of the iceberg and most air transport companies are suffering a huge fall off in business. For many airlines all current efforts are dedicated to just surviving this dramatic downturn in business and a massive reduction in aircraft and personnel has already been announced on a global scale. Everyone engaged in the business has to believe that the recovery will occur shortly (ten to eighteen months time). In the interim, many fine aviation professionals are about to find themselves in changed circumstances, only temporarily we hope. For management the challenge is to oversee the scaling down of the industry to the prevailing new conditions so that experience and competence are retained and safety is not compromised.

Many CEOs and corporate leaders in the industry have come to their positions from outside the aviation experience. Those of us involved in aviation over the longer term know the cyclical nature and volatility of the business. We can remember the difficulties of the Oil Crisis of the early and mid 1970s, of the world recession of the early 1980s, of the Gulf War of the early 1990s and now this! If you came from outside the industry you can be forgiven for a reaction that only addresses the short term. However, you would do well to heed the advice of those with a longer aviation memory. Our industry will recover from these difficulties and commence to grow again, hopefully in a shorter timescale than most currently anticipate. Inevitably, this growth will be epitomized by a shortage of experienced personnel, inadequate resources and short term reactionary planning. The recent UKFSC Seminar "Gearing up for Safe Growth" gave those present a picture of the difficulties that the recovery in aviation will bring e.g. do you know that the greatest number of pilot retirements will occur in 2007/8. When that "bulge" of experience departs, what provisions will be in place to restore the safety shield experience provides. As one of those scheduled to go in 2007 I predict that we will be in the middle of the next boom and unless provided for the exodus will have a significant effect on that development.

There is a requirement to manage the present downsizing while making provision for the future. Has your organisation identified key staff you would wish to retain if circumstances were different? Have you compiled a list of the order in which you will rehire when the recovery takes place? Have you communicated to key personnel these aspirations and solicited their response, allowing you to plan the future. Good proactive management now will repay handsomely in the future. Remember, "those who can not remember the past are condemned to repeat it" (George Sante Ayana).

As this is the Winter Focus I will not be speaking to you again until the New Year. I make no apology if the message appears downbeat but it reflects the reality of the times in which we now live. However, we must not let it inhibit our celebration of the upcoming festive season with family, friends and colleagues. I wish you all a very happy and peaceful Christmas and a much better year in 2002 than we have had in 2001. Thank you one and all for your support and work on behalf of aviation safety in the past year.

by Peter Martin

11 September 2001
Do some legislative responses in the UK point to what could happen here?

In the United States the legislative response to the tragic events of 11 September has been rapid insofar as protection of the airline industry is concerned.

Under the newly enacted Air Transportation Safety and System Stabilization Act President Bush funded the DoT's "Compensation for Air Carriers" account and delegated authority to the DoT Secretary to disburse the money. The Act allows the President to compensate air carriers for both direct and incremental losses suffered on 11 September 2001 and the resulting ground stop order that temporarily shut down the UK air transport system.

Up to USD 5 billion is authorised by the Act.

Furthermore, cash and loan guarantees comprise a further USD 10 billion bailout plan for US air carriers allegedly struggling to recover from the effects of 11 September, also authorised by the Act. The plan is that this compensation and bailout fund would enable airlines to maintain short-term stability as they work towards long term viability.

A fund of USD 3 billion has been created for extra or expanded security in a variety of forms.

What is even more interesting is that the liability of an individual carrier with respect to the events of 11 September, in other words the liability of the airlines whose aircraft were hijacked and crashed, is limited to the maximum amount of the insurance coverage of the airline concerned. This is critical as, potentially, victim's families (including the families of victims working in the WTC) have substantial claims to make against the airlines and airport operators arising from allegations of security failure – as for the owners of the buildings themselves and their losses, they also have claims arising out of their physical and economic losses. Potentially astronomic claims estimated in the tens of billions of USD.

However, and very wisely as I see it, the Act also established a relief fund to compensate victims of the attacks and their families. Claimants may sue in New York or apply for relief from the fund with relief to be administered by a court official with judicial status.

A further provision of the Act freezes airline executive salaries of USD 300,000 or more.

Politically, the passage of the new Act was not so easy. One Senator complained that the bailout was shareholder protection at the expense of the taxpayer – a cry we have heard here recently in the matter of Railtrack! and it is also true that the Act does nothing to help the thousands of airline workers and workers in related industries, laid off since the attacks and for whom the work prospects do not currently look promising.

The fallout from 11 September will continue, in airline terms, to create serious economic difficulties for months and possibly years yet. For example, the US DoT currently requires carriers in the US to give notice of reduced or curtailed services to US communities in view of the sudden, unilateral service reductions following 11 September. Although this requirement is temporary, expiring on 31 December 2001, it must be more than likely it will be renewed if economic conditions do not obviously improve.

In Europe, airlines, also hard hit, have lobbied the EU Commission for a relaxation in the competition rules to enable them more freely to co-operate without being held in contravention; there are also calls for relaxation of the "state aid" rules. Airlines are also considering complaints against the decision of war risks insurers unilaterally reducing war risks covers to a maximum of USD 50 billion – already a relatively trifling sum given the risks!

Postcript - more in next issue.

On 11th October Mr Justice Tomlinson delivered judgement in the High Court in a case of great interest to all operators and pilots. In Knight Air and others - v - Embraer and BF Goodrich a claim was made against the manufacturers of Bandeirante G-OEAA and its artificial horizons arising from an accident in the UK on 24 May 1995 in which G-EOA crashed and all lives were lost. The claimant's allegation that loss was due to horizon failure was rejected. The judge held cause was failure of pilots to handle aircraft with "the competence and skill reasonably to be expected of them", "as commercial pilots were to be expected to be able to maintain control in the event of failure of one or even both horizons". Costs awarded on an indemnity basis, a sign of the disapproval by the judge of the failed attempt by the claimants to recover.

False or Erroneous Glide Path - Be Aware!

The following is a preliminary synopsis of an investigation currently in progress by Air New Zealand and the New Zealand CAA. Michael Carrelli of the NZ CAA gave a presentation on this subject to UK operators at British Airways Cranebank on 7th November 2001.

Early on the morning of Sunday 30th July 2000 the Air New Zealand Duty Line Manager was notified of a suspected false glideslope capture experienced by Air New Zealand flight NZ 60 during approach to Faleolo International Airport, Apia, Western Samoa.

NZ 60 had been cleared to Faleolo via a FALE arrival for an ILS runway 08. The approach was planned to be an autocoupled ILS, using a low drag approach profile. During descent the aircraft was established on the 15 nm arc as per the STAR procedure.

Approaching the localizer course at 2800 ft LOC was armed, the autoflight system subsequently captured the localizer inbound course. During the turn onto the localizer the aircraft was decelerated and configured to Flap 1. APP was armed after localizer capture and the autoflight system captured the glideslope shortly after. The crew reported an energy increase, with speed increasing to near the flap 5 limit speed. To assist with energy control, while continuing to configure the aircraft for landing, the crew used speedbrakes and landing gear. The flight instrumentation glideslope deviation indicators displayed 'on glideslope' throughout the approach.

Shortly after landing flap selection the PF (Pilot Flying) noted an anomaly in DME vs. altitude. Around the same time the PNF (Pilot Not Flying), while trying to establish visual contact with the airfield and runway, became aware that visual cues did not correspond with what was expected. The SP (Supplementary Pilot) also became aware of an anomaly in aircraft position at approximately the same time as the two other crew members.

A go-around was commanded, initially climbing straight ahead followed by a climbing left turn, to pick up the 340° radial FA VOR to rejoin the 12 nm arc for a subsequent approach. This approach was flown with careful attention to distance and altitude, using the published DME recommended altitudes for glidepath management. The glideslope deviation indicator also indicated on glideslope throughout the second approach. The glideslope indications were ignored and the approach continued to a successful landing.

After reviewing their fitness for duty following the event, the crew elected to continue the tour of duty and return to Auckland. An autocoupled approach back into Auckland was normal.

The Flight Data Recorder was removed from the aircraft, and Air Traffic Control at Faleolo was requested to issue a NOTAM stating that the glideslope was unserviceable.

The aircraft had descended on a glidepath of approximately 3.5° to a point approximately 51/2 miles short of the runway with 'normal' localizer and glideslope indications displayed on the flight instrumentation. It was later established that the ILS glideslope transmitter had inadvertently been left in control bypass mode, with the unserviceable transmitter selected. This resulted in the glidepath transmitter executive monitor being unable to shut down the faulty transmitter or to transfer to the serviceable transmitter. The result was the transmission of invalid glideslope guidance information.

Two proving flights were subsequently conducted at Auckland using runway 05, to document the effects on the aircraft.

Editors Note

This incident is at present being further investigated by the New Zealand CAA and ICAO but there have been other incidents where, although promulgated as being under maintenance or 'on test', the ILS has been used, sometimes with near disastrous consequences. Operators are being asked to bring this to the attention of all aircrew and to report any incidents to the appropriate authorities.

The NZ CAA has as yet not completed their report. It is expected to be completed some time in the first quarter of the New Year. The report when completed will be published on the NZ CAA Website.

Operational use of Angle of Attack on Modern Commercial Jet Airplanes - Part 1

Angle of attack (AOA) is an aerodynamic parameter that is key to understanding the limits of airplane performance. Recent accidents and incidents have resulted in new flight crew training programs, which in turn have raised interest in AOA in commercial aviation. Awareness of AOA is vitally important as the airplane nears stall. It is less useful to the flight crew in the normal operational range. On most Boeing models currently in production, AOA information is presented in several ways: stick shaker, airspeed tape, and pitch limit indicator. Boeing has also developed a dedicated AOA indicator integral to the flight crew's primary flight displays.

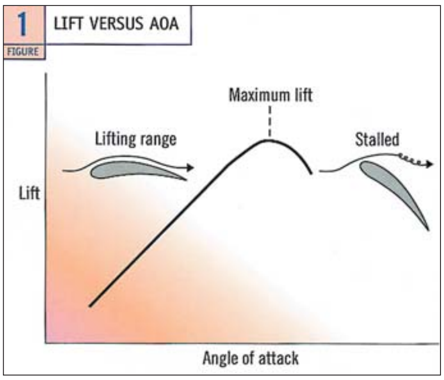
Since the early days of flight, angle of attack (AOA) has been a key aeronautical-engineering parameter and is fundamental to understanding many aspects of airplane performance, stability, and control. Virtually any book on these subjects, as well as basic texts and instructional material written for flight crews, defines AOA and discusses its many attributes.

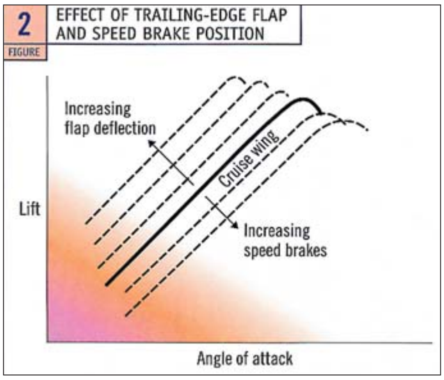
AOA can be used for many indications on the flight deck to improve flight crew awareness of airplane state relative to performance limits. Dedicated AOA indicators have been used on military aircraft for many years, but this form of display has not been used often on commercial airplanes. On Boeing models currently in production, AOA is used to drive stall warning (stick shaker), stall margin information on airspeed indicators, and the pitch limit indicator (PLI) on the primary attitude displays. AOA information is combined with other data and displayed as an integral part of flight deck displays.

Recent accidents and incidents have resulted in new flight crew training programs for upset recovery and terrain avoidance, and these in turn have heightened industry interest in AOA as a useful flight parameter for commercial aviation.

The U.S. National Transportation Safety Board (NTSB) has recommended visual indication of AOA in commercial airplanes. This indication may take the form of a dedicated AOA indicator or other implementation, such as the PLI.

A dedicated AOA indicator shown on the primary flight display (PFD) recently has been developed in cooperation with airline customers. The new indicator is offered as an option on the 737-600/-700/-800/-900, 767-400, and 777 at this time.





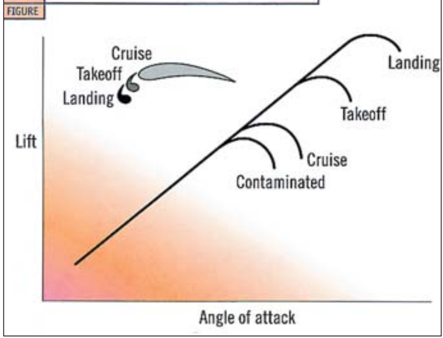
During the development of the new indicator, discussions with airlines, the NTSB, and U.S. Federal Aviation Administration (FAA) pilots and engineers provided a unique opportunity to examine potential uses of AOA and the many existing uses that have evolved in recent decades along with advances in display and indication technology.
This article discusses the following:

1. Basic principles of AOA.
2. Airplane performance and AOA.
3. AOA measurement.
4. AOA indications and flight crew procedures in current Boeing production models.
5. Design and uses of a separate AOA indicator.

1. BASIC PRINCIPLES OF AOA

AOA is one of the most important parameters for understanding airplane performance and handling because a

FIGURE 3 EFFECT OF LEADING-EDGE POSITION



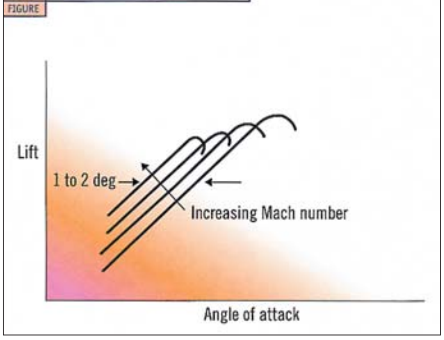
typical wing has a limited range of angles of attack over which it can function efficiently. In its simplest form, lift is a function of speed, air density, wing area, and AOA. At a given airspeed, as the AOA of a wing is increased, lift also will increase (fig. 1). Therefore, at the same airspeed, a heavy airplane of the same configuration must fly at a higher AOA than a light one. Conversely, as an airplane decelerates, the AOA must be increased to maintain the same lift. So, in the normal operational range, there is a relationship among lift, speed, and AOA. This relationship will change if the AOA gets too high (fig. 1). The air flowing over the wing will separate from the upper surface, resulting in a loss of lift, or a stall. It should be noted that this stall condition could occur at a wide range of speeds (depending on the airplane weight or load factor, or g loading) and at any attitude (depending on the flight path angle). What is important is the AOA. Therefore, it is imperative to know when the wing is approaching the stall AOA and to take steps to avoid it.

However, many other parameters influence the lift that a wing produces. The most basic is the configuration of the wing, specifically the position of the trailing-edge flaps, leading-edge flaps or slats, and spoilers. As the trailing-edge flaps are extended, the curvature (or camber) and area of the wing are increased, and the wing will produce more lift at the same AOA (fig. 2). Note that although the maximum lift is increased, the AOA at which stall occurs is actually less because the wing cannot sustain the higher lift levels up to the same AOA. The airflow separates earlier.

Wing-mounted speed brakes or spoilers have the opposite effect. They reduce the lift at a given AOA; they also reduce the maximum lift achievable but, surprisingly, increase the AOA at which stall occurs.

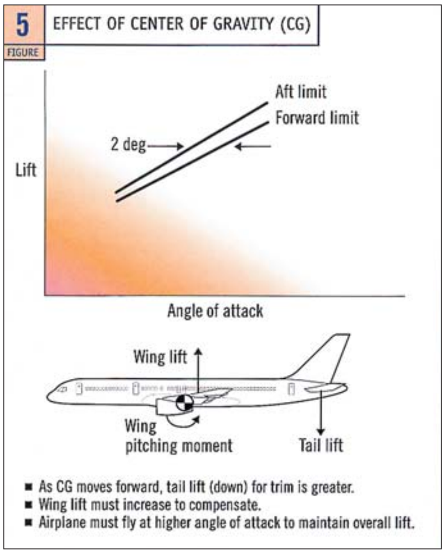
Leading-edge devices, such as Krueger flaps and slats, permit the wing to operate at a higher AOA before it stalls by delaying the flow separation. Figure 3 illustrates this and the effect of contamination, such as ice or dents, on the leading edge. Contamination can cause the airflow to separate at a lower AOA, causing the wing to stall at a lower AOA than expected. While these effects are accounted for in the airplane design and maintenance program, it is important to remember this

FIGURE 4 EFFECT OF MACH NUMBER



potential variability in stall AOA (see "Winter Operations-Keep It Clean," Airliner, Oct.—Dec. 1983).

On most transport category airplanes, the lift that the wing produces is also a function of Mach number, particularly as the airplane approaches transonic speeds



typical of cruise flight (fig. 4). Of course, lift at a given AOA will increase with speed, but even at the same airspeed, as Mach number is increased (the speed of sound changes with temperature), lift will increase.

However, higher Mach reduces the maximum lift the wing can attain and the AOA at which stall occurs. This means that as gross weight, altitude, or load factor is increased, the resultant increase in Mach number will cause a stall at a higher speed and lower AOA. This is true even at takeoff and landing speeds with the flaps down.

The center of gravity (CG) also affects the lift that the wing must produce. As the CG moves forward, the nose-down moment increases because of the airplane weight and wing lift (fig. 5). Therefore, the downforce on the horizontal tail required to trim is increased. This means that the wing must provide enough lift to compensate for the download on the tail in addition to the weight of the airplane. Note that the AOA of stall is not changed, but the lift required of the wing is greater, and therefore the stall speed is increased.

Thrust also can affect lift in three ways. First, the component of thrust that acts in the lift direction offsets some of the lift required of the wing (fig. 6). Therefore, as thrust is increased, the AOA for trimmed flight is reduced and the maximum lift is increased. Second, thrust changes the airflow around the wing and flaps, which does not usually have a large effect on jet transport airplanes. Third, thrust affects airplane trim, usually by reducing the download on the tail (see previous paragraph on CG).

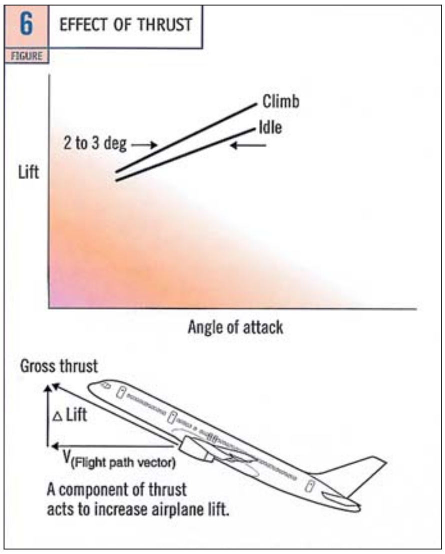
The examples cited above show that many parameters affect the relationship of lift and AOA. For AOA information to be useful to a flight crew, these parameters must be considered and accounted for in the indications and associated crew procedures.

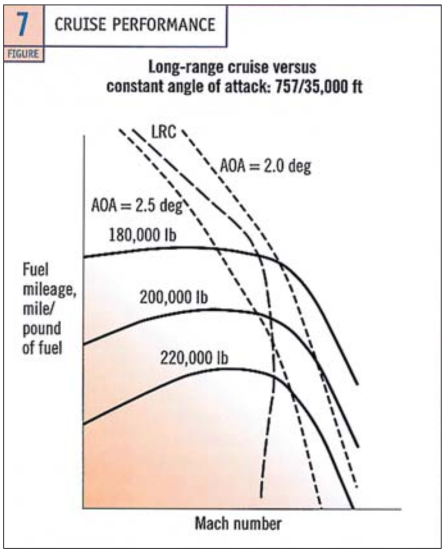
2. AIRPLANE PERFORMANCE AND AOA

Takeoff. During rotation, pitch angle is the critical parameter that ensures tail clearance. Once the airplane is airborne and at a sufficient altitude where ground effect and crosswinds do not affect the sensor reading, AOA will provide valid information.

During takeoff climb, there is no single target AOA to fly that will guarantee certified takeoff performance. Takeoff-climb AOA will vary with such factors as airplane gross weight, thrust, altitude, flap setting, and CG. Takeoff-climb speeds (hence, AOA) are limited by stall speed, tail clearance, and minimum control speeds. The higher speed and greater thrust of an all-engine takeoff reduce the AOA significantly relative to an engine-out takeoff at the engine-out climb speed (V2).

The key to optimal takeoff performance is to “fly the speeds.” The takeoff flight path that guarantees clearance of all obstacles ahead is calculated based on flight at these speeds. Following rotation at VR, V2 is the resulting engine-out speed at an altitude of 35 ft and is usually slower than that for best lift-to-drag (L/D) ratio or angle of climb. However, if the nose were to be kept down and the airplane accelerated to higher speeds, short-term climb performance would be sacrificed and a close-in obstacle may not be cleared.





Cruise. Range is a function of both the aerodynamics of the airplane and the fuel-flow characteristics of the engines. Aerodynamically, the minimum drag point occurs at the point where the L/D is a maximum. But this value depends on both AOA and Mach number, so the optimal AOA will vary as Mach number is changed.

The fuel-flow characteristics of the engines are not affected by AOA, but they do depend on the thrust required (drag), Mach number, and temperature.

Combining the wing and engine characteristics yields the fuel mileage of the airplane, so fuel mileage is a strong function of Mach number. Figure 7 shows the fuel mileage of a 757-200 at an altitude of 35,000 ft as a function of gross weight and Mach number. It can be seen that the optimal long-range cruise Mach number does not vary significantly as gross weight (hence, lift and AOA) changes. Superimposed on this chart are two lines of constant AOA. It is apparent that flying a constant AOA will not yield optimal performance. If a flight crew tried to fly a target AOA and there was an error of as little as 0.5 deg, the penalty in fuel mileage could be 3 percent or more.

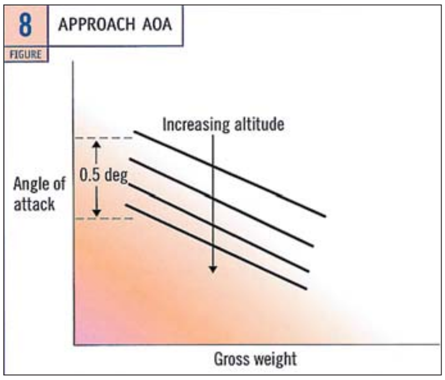
Wind is a more fundamental consideration. For best fuel mileage in a head wind, the airplane should be flown faster than the speed for best range in still air; in a tailwind, it should be flown more slowly. Most modern Boeing airplanes have a flight management computer (FMC) that accounts for airplane, engine, and wind characteristics and can compute the optimal speed to be flown.

Approach speed. Approach speed is critical to landing performance and is established during the airplane certification process. It is determined not only by margin above stall speed but also may be increased by consideration of minimum control speed and tail clearance at touchdown.

Regulations require that the approach speed be no smaller than a specific multiple of the stall speed. Because stall speed is a function of Mach number, stall-limited approach speed will occur at a different AOA at different gross weights and altitudes (fig. 8).

Those airplanes that do not account for the variation of stall speed with Mach number set the approach speed at the most conservative altitude. The speeds also allow for the most adverse CG (forward) that requires the most lift out of the wing, resulting in the highest stall speed and, therefore, the highest approach speed.

In addition, the approach speed cannot be smaller than a multiple of the minimum



control speed in the landing configuration (Vmcl). This speed is not significantly influenced by movement of the CG. So, during an approach at the aft CG, if the flight crew reduces speed to fly at the same AOA as required for the forward CG, an approach speed below the minimum control speed may result.

A further consideration is the clearance of the aft body from the ground as the airplane lands. Some airplanes, particularly those with stretched fuselages, have increased approach speeds to reduce the AOA and hence the pitch angle on touch-down. This provides adequate clearance between the body and the ground at the most critical CG.

However, in revenue service, CG is rarely at the forward limit. So, if the approaches were flown on a daily basis by reference to a fixed-approach AOA based on a margin above stall, at any CG aft of the forward limit, the probability of tail strike would be greater than the current practice of using approach airspeeds.

In addition, variations in thrust will affect the approach AOA-speed relationship. From the discussion above, it can be seen that approach speed may be limited by many different requirements and that no single AOA can be targeted to ensure proper speed or landing attitude margins.

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Part 2 will appear in the next issue of FOCUS.

What is Angle of Attack?

Angle of Attack (AOA) is the angle between the oncoming air or relative wind and a reference line on the airplane or wing. Sometimes, the reference line is a line connecting the leading edge and trailing edge at some average point on the wing. Most commercial jet airplanes use the fuselage centerline or longitudinal axis as the reference line. It makes no difference what the reference line is, as long as it is used consistently.

AOA is sometimes confused with pitch angle or flight path angle. Pitch angle (attitude) is the angle between the longitudinal axis (where the airplane is pointed) and the horizon. This angle is displayed on the attitude indicator or artificial horizon.

Flight path angle is defined in two different ways. To the aerodynamicist, it is the angle between the flight path vector (where the airplane is going) and the local atmosphere. To the flight crew, it is normally known as the angle between the flight path vector and the horizon, also known as the climb (or descent) angle. Air mass-referenced and inertial-referenced flight path angles are the same only in still air (i.e., when there is no wind or vertical air movement). For example, in a headwind or sinking air mass, the flight path angle relative to the ground will be less than that referenced to the air. On the newest commercial jet airplanes, this angle can be displayed on the primary flight display and is calculated referenced to the ground (the inertial flight path angle).

AOA is the difference between pitch angle and flight path angle when the flight path angle is referenced to the atmosphere. Because of the relationship of pitch angle, AOA, and flight path angle, an airplane can reach a very high AOA even with the nose below the horizon, if the flight path angle is a steep descent.

A chilling danger on the club scene

by Dr Jackie Stone
Emirates Medical Clinic

As flights stop over in many destinations where this can happen, you need to know about the phenomenon known as Drug Rape. Although not immediately apparent, this does affect the majority of flight deck crew; you are responsible for the rest of the crew whilst down route and should have this background information if anyone on your crew is attacked in this way. "Wealthy" visiting foreigners may also be targeted for reasons other than rape.

As Dubai becomes more cosmopolitan, the same vigilance should be applied at home. The key to preventing this from happening is awareness and I would urge you to tell your friends to be aware, too.

The following story is a summary of an article in the South African magazine, Fair Lady.

Louisa doesn't remember much about the Thursday night that will haunt her for the rest of her life. After she'd finished work, she went to meet some friends for a drink. "I was first to arrive," she says, "so I decided to have a drink in the meantime."

While she was standing waiting to be served, she started chatting to the man standing next to her. When he offered to buy her a drink, she accepted. "I got a rum and coke, and I'd had about half of it when I started to feel really drunk. My legs felt wobbly and I was slurring my words. Then I blacked out." After that, Louisa remembers only fragments: an engine revving up; a key turning in a lock, doors slamming, a heavy body on top of hers.

"When I woke up it was light" she whispers, "I had no idea where I was. She got dressed and let herself out of the apartment. She found herself a few blocks from the pub where she'd parked her car. When she got into her car she was a wreck. "I didn't and still don't know exactly what happened to me. I can remember bits - a man's voice, feeling someone on top of me. But it's like remembering a dream. You know there's more but however hard you try, you can't quite get a hold of the memory. I went back to work the next day but I wasn't functioning. I was withdrawn and couldn't concentrate."

Eventually, a week later, Louisa told a friend that she thought her drink had been spiked and that she'd been raped. "She told me to go to the police but I refused. Even I couldn't be 100 per cent sure of what had happened, so what could the police do?"

One of the magazine's reporters took a dose of the drug commonly used in Drug Rape in a doctor's surgery, while a colleague observed her and reported on her reactions.

"If you met Sarah after taking the drug you wouldn't have thought there was anything wrong with her. She appeared quietly drunk. And while she couldn't remember things from five minutes ago, she could remember things from last week. Fifteen minutes after taking the drug, Sarah took longer to follow what was being said. She asked to go to the toilet but I said we couldn't leave the room without the doctor. Two minutes later she asked to leave the room again, and I reminded her we were waiting for the doctor. Minutes later she asked again. More notable however was the way that Sarah lost her inhibitions. And that was without the aggravating effect of alcohol."

Sarah remembers taking 1mg of the drug at 11.30am in the doctor's rooms. 15 minutes later, she felt like she had had two or three drinks.

"Then things started to get patchy. I was aware that I was shedding my inhibitions.

At the same time I felt clumsy and uncoordinated. I did a memory test and out of a one-minute story, I could remember one word. By 2pm I was home. All I wanted to do was lie down. We watched a video but I don't remember what happened. At 6.30pm I woke up feeling like I'd been on a drinking binge." These were the results of 1mg of the drug, under strictly supervised conditions, with no alcohol.

How common is Drug Rape?

Official statistics on Drug Rape do not exist, but rape counsellors believe that the cases reported represent the tip of the iceberg. In the UK, within 18 months of a national drug rape helpline being established, more than 1,400 calls were received. That works out at close to 80 reported drug rapes a month, or two to three a day.

Women are ambivalent about reporting drug rapes, as they sometimes feel responsible for what happened. Many drug rapes happen after women have been drinking. In addition, because they have memory loss they feel there is no point in reporting the rape. A male nurse in the UK recently received seven life sentences for Drug Rape and it is hoped that more people will come forward and report their experiences when they realise that something can be done.

Who are the rapists?

Rapists fall into four categories, according to a British expert, and all may use drugs to achieve their purpose:

The opportunist, who hadn't planned to get a particular woman, but sees his chance and takes it.
The rapist who has fancied someone for ages and plots how he will get her.
The serial rapist who gets a kick out of drugging women.
The heavy-duty porn merchant who films drugged women.

What drugs are used?

There are a number of tranquilisers used to spike women's drinks. Most belong to a group of drugs known as benzodiazepines. They are available from pharmacies on prescription and used for the treatment of insomnia. Some are used as "premeds" before surgery. Some are used to sedate patients who do not need a general anaesthetic. Some of the drugs are seven to 10 times as strong as Valium. They can knock you out in minutes, and cause such memory loss (amnesia) that you may not even know you've been raped. All the drugs are enhanced by alcohol. Within three days, all traces of the drug are gone from your body.

What is being done about it?

Some manufacturers are "extremely concerned" about these tablets being used in this way. Some have added a blue dye to the tablets, reduced the dose and made them more difficult to dissolve. Campaigners say this is not enough. You cannot spot a blue-colored dye in a dark drink, and there is nothing to stop the rapist from putting in two tablets. Manufacturers are against adding an unpleasant taste, as this would affect millions of legitimate users. The CEO of the Pharmaceutical Manufacturers Association of South Africa says: "All medicine is potentially dangerous and can be abused by unscrupulous operators. Women have to be diligent and know who they're socialising with."

What can you do about it?

1. Think very carefully before you accept a drink from a stranger.

2. Watch your drink being poured.

3. Don't leave your drink unattended, then come back and drink it.

4. If you start to feel very drunk after one or two drinks, tell a friend quickly that you

think your drink has been spiked. Waiting a few minutes might be too late.

5. Look after your mates and other crew. If you see a crew member behaving unusually after a few drinks, or going off with a stranger, check that they're okay.

6. Beware of venues that offer free drinks and special treatment for crew (for example bars in Melbourne and Europe) as a drink can possibly be spiked behind the bar.

7. Try to go in a group and agree beforehand that you will leave together.

8. Don't leave the venue without making sure that everyone is accounted for.

9. Try not to stay at a venue alone or leave anyone at a venue alone - especially if they are acting in an uninhibited way and are slurring their words.

What happens if you suspect you have been drug raped?

If you are in Dubai:

Come to the clinic the next morning. We will arrange

1. That emergency contraception is given where needed.

2. That you have a full screen for sexually-transmitted diseases.

3. That emergency HIV treatment is started if necessary.

4. That you have psychological follow-up and counselling if necessary.

5. That blood is taken and stored in case you need to prove that this was a drug rape.

6. That we document evidence of rape, bruising, assaults and so forth. This will be important if you are able to prosecute.

7. That any evidence of rape is collected, in case testing is required for a conviction.

If you are down route:

1. Contact a senior crew

2. Member - the Captain, CSD or SFS — whoever you feel most comfortable with.

3. Contact the hotel doctor and tell him what has happened. He will arrange for someone to take blood to test for drugs, and document any evidence of rape or assault, including collection of any specimens that might convict the rapist. He will also start anti-HIV treatment if appropriate.

4. Come to the clinic immediately you return to Dubai.

This will be totally confidential. Divulging medical information without the patient's consent is a dismissible offence.

The key to Drug Rape is prevention. However, if you are cautious and sensible, it will hopefully never come to this. If you know any crewmembers to whom this has happened, we suggest you tell them to come to the clinic for assessment regarding sexually-transmitted diseases and the need for psychological treatment.

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Unruly Passengers – Déjà Vu

The April 2000 (#250) issue of CALLBACK featured an article on the adverse effects of passenger misconduct on flight crews. Included was an ASRS report about a drunken passenger carried on board an airliner in a wheelchair by the airline's passenger assistance staff. The Captain involved in this incident commented:

Someone needs to counsel these people that while their job may be to assist passengers, it is not to assist drunken passengers on the airplanes. I feel that if a guy is too drunk to walk on the airplane, then he is too drunk to ride for 2 hours on the same full airplane.

Unfortunately, that report wasn't an isolated incident. ASRS recently received a report submitted by a Flight Attendant describing an almost identical event:

I was walking through the cabin checking carry-on bags when the involved passenger asked me where his bags were. I had a difficult time understanding him because he was slurring his words. He became confrontational. I then went to the First Class galley and asked the #1 [Flight Attendant] if he knew what was going on. He didn't, but the greeting Flight Attendant did. He said he [the passenger] was too drunk to walk, so he was boarded with a wheelchair. I questioned why we were taking a passenger who was obviously intoxicated and was told by ground personnel not to worry about it, they gave him coffee and he'd be fine. I didn't like that answer so I voiced my concerns to the Captain and the passenger was removed.

The crew's response in this situation was "right on". FAR 121.575(c) states, "No certificate holder may allow any person to board any of its aircraft if that person appears to be intoxicated." A 1998 ASRS study on passenger misconduct incidents concluded that passengers should be monitored for intoxication and erratic behaviour prior to boarding, and denied boarding if their behaviour appears likely to pose a safety hazard during flight.

Another recent incident reported to ASRS by an air carrier Captain involved an altitude deviation related to a passenger disturbance:

During descent my first Officer was tending to a belligerent passenger. I was flying and executing clearances single pilot. At 10,700 feet Centre instructed me to level at 11,000 feet. I complied…It was unclear to me whether we were cleared to 11,000 feet or 10,000 feet. I debriefed Centre and they said everything was OK.

Flight crews involved in similar situations may want to consider notifying ATC of the single-pilot cockpit operation while internal flight problems are being resolved.

Book Review

Attitude or Latitude?

Australian aviation safety

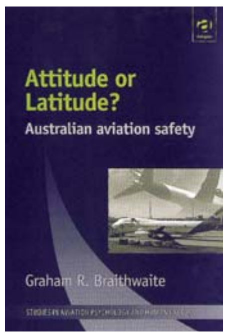
STUDIES IN AVIATION PSYCHOLOGY AND HUMAN FACTORS
Graham R Braithwaite, University of New South Wales, Australia
ISBN 0 7546 1709 2
Price: £47.50

CONTENTS:
Australia's safety record; Defining safety; A new approach to safety?; Exploring the physical geography; Exploring the human geography; Culture is not spelt with a "k"; Comparative safety; Exploring the human environment; The lucky country…; Exploring the operational environment; Infrastructure and support; Understanding the safe system; Epilogue; References; Index.

Australia has an enviable record for airline safety – No one has every died in an accident involving a commercial jet aircraft in Australia. The reasons behind this have been the source of much speculation and theories tend to focus on issues related to the natural environment and even luck. However, with human error being present in arguably 100% of aircraft accidents, it seems reasonable that a good safety record is at least partly the consequence of human intervention.

This text uses Australian aviation as a case study of a safe system to explore the interactions between the natural, operational and human environments.

Based on doctoral research including a major survey of pilot and air traffic controller perceptions, the book is unusual in that it looks at positive examples in safety rather than taking the traditional reactive approach to safety deficiencies.
September 2001



Gearing up for Safe Growth
A Review of the 2001 UK Flight Safety Committee Seminar

by Peter G Richards I Eng FRAeS. UKFSC Communications Officer

The Annual Seminar by the UK Flight Safety Committee essentially tries to focus on the aspect of safety that the industry most needs to address. The topic, chosen about one year in advance of the event, this year was based on the UK Government Discussion Paper "The Future of Aviation".

Inevitably, our Seminar was heavily overshadowed by the terrorist events of September 11th in the USA. Thus, there were no delegates present from the US and very few from within Europe either. The coincidental recessionary profile, that the world's airlines find themselves in, also contributed to a decline in morale in all sectors of the programme. But many speakers and delegates have the experience of living through such recessions before and can recall how they coped and what lessons learned need applying again this time. The trick will be to use the 'breathing space' the September 11th has tragically given us to rejuvenate the shortages and limitations to safer growth.

Lord Stanley Clinton-Davis of Hackney, the Keynote Speaker, was most eloquent in his plea not to discriminate against 'aviation' when considering any requests for help. Governments have willingly and visibly supported Coal, Steel, Ship building, Automotive manufacturing and Farming. Could it be that aviation is such a prodigious generator of higher paid individuals that it isn't seen as a 'deserving' sector? Try that argument on the Licenced Aircraft Engineers, who, when trained, vacate these shores in their droves to more lucrative employment as contract workers in Germany; a point made later in the programme by Ron Graham, a maintenance engineering foreman.

Should the European Union consider the creation of a Mutual Fund to support any 'deserving' ' business sector in these sorts of troubled times? Lord Clinton-Davis thought so and that there might be a dedicated Aviation Security Task Force to restore some of the lost confidence too.

Aviation, in the macro sense in the UK, is largely dominated by two or three world class organisations, with numerous smaller operators and a vast multitude of sub-contractors and suppliers. Along side them are a group of growing and diversifying manufacturing and operating companies all of whom are competing for a small pool of appropriately skilled labour. Tony Ingham, a former CAA Chief Surveyor, reminded us of the political decision in 1981 to discontinue with the 1964 Act that created the Industrial Training Boards. This decision was made, to save the 1% pay roll levy, cutting the feet from under some structured apprenticeship training schemes. The drive for lower fares promoted a furious demand for mass travel capacity that could only be resourced in terms of aircraft safety by the skilled engineers; who have now, through demography, largely disappeared. The Aviation Training Association, a poor orphan of the Air Travel and Transport Industry Training Board, never enjoyed the support of Industry. It is left to such bodies as the Royal Aeronautical Society and the Association of Licenced Aircraft Engineers to lobby the regulator with advice on how to maintain standards and promote that elusive level of self-esteem in the workforce.

The Royal Air Force appears to enjoy a much healthier profile for its technical resources, owing much I believe to some detailed analysis from a number of recent

Lord Clinton-Davis

conflicts and a re-structuring following the recent Defence Review. Wing Commander Sue Gray was speaking from a Tri-Service evaluation perspective, but was quick to add that there was little surplus manpower to offer the civil airlines and maintenance organisations to poach. With higher salaries within the services, why bother to leave? The focus they have changed is to align the historical multi-faceted trade skills towards the B1 and B2 syllabi more in line with JAR 66 licences. From further research, it is apparent that there are some good quality, 'spare training capacities' within the RAF and mechanisms are already being explored to enable civilians to gain access to them.

Capt. Paddy Carver, SFT Aviation bewailed the 'sausage machine' Audio Visual Techniques 'Need to Know' style aircrew training infrastructure, that certainly produced systems handling skills, but no ability to think under pressure. He felt that selection rarely seemed to assess the 'ability to learn' leading to diminished levels of competencies and a rejection of training as the most vital dimension of Continuing Professional Development. This may seem surprising when viewed against the continuous cycle of 6 monthly 'checks and refresher training' that all civil aircrew receive. With the programme for these days in the simulator readily available in advance or following a prescribed pattern, the level of professionalism is at risk from familiarity. As any aircrew will tell you, most incidents tend to be unique, or possess uniquely unexpected facets to resolve. What is essential for aircrew to function is total confidence in their technical knowledge of the aircraft underpinned by competent command leadership and a sound safety management system culture within the airline.

Kathleen Nuttall, Vice President of the Guild of Air Traffic Control Officers, gave a slightly humorous perspective to a resource stretched too thin for comfort. Her pastry rolling analogy has delivered a pan European ATCO shortage of 10-12% and predicted such expansion handicaps as Flow Controls, and exhorted the delegates and the wider world to use this current commercial pause to build up key staff resources.

Paul Kehoe from London-Luton Airport Operations gave a polished performance on the risk management culture now very much the flavour within airline managements. He warned of the chaos that can ensue when aircraft turnaround times are cut to increase utilisation and reduce costs; echoing the UKFSC Chairman Tom Croke with his opening address featuring the sinking oil rig while the construction manager extolled the virtues of cost cutting.

Peter Martin, the UKFSC's Hon. Legal Adviser, was asked to give us a summation based on his feelings from the Seminar. In a word, "Depression". How and Why have we let things get to such a pass? The 20 years since the demise of the Training Boards has seen nothing short of a steady sale of the 'family silver' and it is going to take a lot of serious investment to put it right. Ron Elder, the CAA Head of Engineer Licencing, was provoked by questioning from the floor into these sombre words. "Planned expansion by airlines will not be agreed by the Regulator without the correct levels of appropriate engineering cover," and Peter Hunt, the Head of Operating Standards Division of the CAA, challenged the Seminar theme with the question "Who has the plan?" If the airline management 'mindset' remains dominated by 'marketing people' I sense a need for a heavier regulatory hand.

Thus the Licenced Aircraft Maintenance Engineer becomes our most 'critical resource' and it would be a foolish management team that idly puts their collective head in the sand and hope they can 'poach' enough to get a 'green light'. I strongly urge the readership of this magazine to try and obtain a CD ROM copy of the Seminar proceedings, as there are lessons to be learned from all the sectors of our industry. It would be tempting

Kathleen Nuttall

to merely look at the financial bottom line of the Seminar and bewail the loss. More of a loss to me, as organising Committee Chairman, was the fact that so few chose to receive the enlightening messages. However the determination by the airline world to 'get things right', that has been demonstrated time after time, gives me strong feelings of optimism that they will respond and get it right once again.

Correction to the article in Issue 44 on RIS/RAS:

The article stated in the second paragraph relating to RAS that the minimum separation is 5nm or 5000ft but AIC 105/2000 (Yellow 29) dated 14 December states "...this minimum will be reduced to 3,000ft throughout the UK with effect from 28 December 2000."

We hope that this now puts the record straight.

Heredity, Disease, Ageing Present Crewmembers with Increased Risk of Hearing Loss

Exposure to loud noises during flight operations and while off duty compounds the risk, but earplugs and headsets help counteract hearing loss.

Hearing loss has a variety of causes, some of them hereditary, some a result of disease and some a normal part of the ageing process. For pilots, and cabin crewmembers - and for people in many other occupations - the risk of hearing loss is compounded by repeated on-the-job exposure to noise, as well as by exposure to loud noises during off-duty hours.

Standards established by the International Civil Aviation Organisation (ICAO) recommend that applicants for pilot medical certificates should "be free from any hearing defect which would interfere with the safe performance of duties in exercising the privileges of the licence."

For a Class I medical certificate, ICAO standards say that applicants shall have, no hearing loss, "in either ear separately, of more than 35 [decibels (dB) at any of the frequencies 500 hertz (Hz)], 1,000 [Hz] or 2,000 [Hz], or more than 50 dB at 3,000 Hz." (Hearing loss often does not occur at all frequencies simultaneously.)

Nevertheless, an applicant with a hearing loss exceeding those specifications could be granted a Class 1 medical certificate, according to ICAO standards, if the applicant "has a hearing performance in each ear separately [that is] equivalent to that of a normal person, against a background noise that will simulate the masking properties of flight deck noise upon speech and beacon signals; and the applicant has the ability to hear an average conversational voice in a quiet room, using both ears, at a distance of two [meters (seven feet)] from the [medical] examiner, with the back turned to the examiner."

In some instances, pilots who do not meet those requirements can obtain medical certificates.

For example, Scandinavian Airlines System (SAS), Capt. Erik Reed-Mohn, who flies McDonnell Douglas MD-80s and MD-90s, has had a restriction on his pilot certificate for more than two years that limits him to flying "with or as co-pilot" because of a hearing loss in one ear.

"I woke up one morning 2 1/2 years ago, and I was deaf in the right ear," said Reed-Mohn, who also is manager of governmental and external affairs for the SAS Flight Academy. "I had a cold . . .so I didn't think about [the hearing problem] until two days later, when the cold was gone and the hearing didn't come back."

Doctors diagnosed a viral infection in his ear and told him that most people who experience similar infections regain their hearing after six weeks to eight weeks. In his case, that did not happen. '"My estimate is that I hear 5 percent [of what I heard before]," Reed-Mohn said. "I was grounded for 2 1/2 months while I went through the tests."

The first tests assessed his hearing and balance. Other examinations were needed to ensure that he did not have a brain tumor. Reed-Mohn said that he learned later that, if he had received steroidal treatment within 48 hours after he experienced hearing loss, he might have been able to avoid permanent damage. Today, he wears a hearing aid in his right ear, and because the aircraft he flies are relatively quiet, he has experienced few problems as a result of his hearing loss, he said.

"I have to tell the co-pilot and the purser that I'm deaf in my right ear," he said. "I have to turn the volume up fairly high [on the speaker]. The only thing I miss is if a co-pilot speaks very softly at the same time I'm listening to [an air traffic controller or recorded information on] the radio."

Morten Ydalus, a Boeing 737 captain for Braathens, lost all hearing in his right ear in 1987, after he fell from a 15foot (fivemeter) staircase, fracturing his skull in several places and destroying the right auditory nerve and cochlea. Afterwards, physicians told him that he would never fly again.

"After one year of sick leave, I got to the point where I had to make a decision on 'loss of licence' and my future. Ydalus said, "When I contacted the head of [civil aviation authority] medical licencing in Norway, he said that it was a possibility that I could get back my license....I had to go through three weeks of medical examinations, [tests by] psychologists and several EEG [electroencephalogram] tests. I have a military background, and luckily, they had old EEGs on file. ...This probably saved my license. After several runs in the simulator, with emphasis on the ability to function with one ear, I got my licence back in 1988 [with the 'with or as copilot' restriction].

"In the beginning, it was a little bit strange. But I adjusted, and after about one year, I really didn't think much about it. At times, the captains I flew with completely forgot that I was deaf in one ear."

When he became a captain in 1995, Ydalus said, "I was a little worried what effect my hearing deficiency would create when I changed seats. In the start, it was worse to sit in the left seat, especially intercockpit communication without [an] interphone. I made it my policy to always brief my co-pilots on my hearing problem; in that way, they also can compensate. Flying generally works without problems."

Stanley R.Mohler, M.D., vice chairman and director of aerospace medicine at Wright State University School of Medicine in Dayton, Ohio, US., said that the experiences of Reed-Mohn and Ydalus in dealing with their hearing losses are typical for airline pilots.

In most instances, pilots who lose hearing have few difficulties adjusting to flying, because they either develop their own strategies for coping with their reduced ability to hear or adjust to flight-deck use of hearing aids to compensate for hearing losses, Mohler said.

There are no special considerations involved in fitting pilots with hearing aids, which today generally are fully digital or digitally programmed analog devices that use digital signal processing to amplify sound, help the wearer hear better and in some instances reduce background noise, Mohler said.

In the United States, the Federal Aviation Administration (FAA) issues airman medical certificates to pilots with defective hearing or deafness. Leslie Downey, administrative specialist in the FAA Aeromedical Certification Division, said that records showed that, as of Dec. 31, 1998, FAA medical certificates were held by 4,210 pilots in that category: 744 of those pilots held first class medical certificates; 1,434 pilots held second class medical certificates; and 2,032 pilots held third class medical certificates. Of the total, medical certificates issued to 175 pilots with the most severe hearing losses -including 15 pilots with first class medical certificates -carry a restriction that the certificate is "not valid for flying where radio use is required." Those pilots were required to pass medical flight tests. Also of that total, medical certificates issued to 1,263 pilots whose hearing loss is less severe -including 89 pilots with first class medical certificates -require that they wear "hearing amplification" during flight. In some instances; those pilots also were required to pass medical flight tests.

Noise-related hearing loss is the second most common form of sensorineural hearing loss; that is, hearing loss associated with damage to the inner ear, auditory nerve or auditory nerve pathways in the brain. (The most common form is age-related hearing loss, also known as presbycusis.)

The human ear consists of the outer ear and the ear canal: the middle ear, which includes the eardrum and an air-filled chamber containing three small bones known as ossicles; and the inner ear, which is composed of the cochlea (the organ of hearing) and the semicircular canals (which together constitute the organ of balance) (Figure I).

The outer ear collects ambient sound waves, which are conducted through the ear canal to the eardrum, a thin, skin-covered membrane separating the outer ear from the middle ear. The sound waves cause the eardrum to vibrate, and the vibration is amplified by the ossicles, which then cause vibration in the cochlea. That vibration results in a pressure wave in the fluid inside the cochlea, and the pressure wave moves thousands of hairlike sensors on the walls of the cochlea. Their movement produces

Diagram of the Human Ear

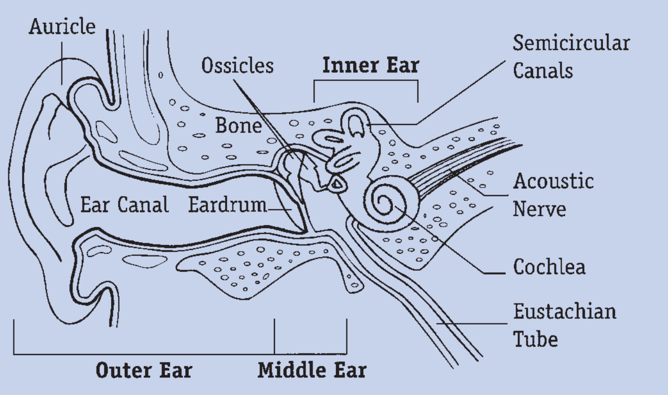


Figure 1

Source: U.S. Federal Aviation Administration electrical signals that are transmitted by the auditory nerve to the brain, which processes the signals and identifies the specific type of sound.

Every sound has three variables: duration; frequency (the property of sound that is pitch -bass or treble, for example), which is measured in wave oscillations or wave cycles per second, known as hertz; and intensity, which is a measurement of pressure or loudness, expressed in decibels. Humans typically can hear sounds with frequencies from about 20 Hz below the frequencies of the lowest notes on a piano, to at least 16,000 Hz or 20,000 Hz higher than the frequencies of the highest notes on a piccolo. Sensitivity is greatest to frequencies between 500 Hz and 4,000 Hz. Conversations, for example, typically occur between 500 Hz and 3,000 Hz.

Each decibel is equal approximately to the smallest degree of difference of loudness ordinarily detectable by the human ear, the range of which includes about 130 dB on a scale beginning with 1 dB for the faintest audible sound. Other sounds on the scale include normal conversation at about 60 dB, a ringing telephone at 80 dB and a jet engine during takeoff at 140 dB.

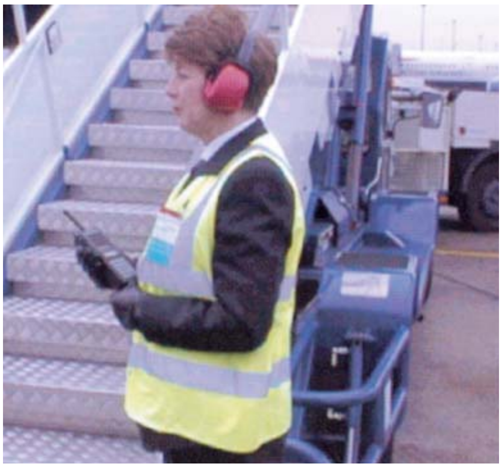
People exposed – without hearing protection – to noises of more than about 85 dB for long periods of time may experience permanent hearing loss.

Temporary hearing loss may follow unprotected exposure for several hours to noises of more than about 90 dB. Unprotected short-term exposure to louder noises may cause other ailments in the ears: Discomfort may occur during even brief exposure to noises of 120 dB, pain may occur during exposure to noises of 130 dB, and the eardrums may rupture during exposure to noises of 140 dB.

"We have some evidence that [crewmembers] do suffer noise-induced loss of hearing over the years of a normal career," said Claus Curdt-Christiansen, M.D. chief of ICAO's aviation medicine section.

In testimony before a December 1999 FAA public hearing on occupational safety and health issues for airline employees, Jerome C.Goldstein, M.D. a member of the board of directors of the Deafness Research Foundation, said, "Aircraft are inherently very noisy machines, and … our concern is that exposure to airplane noise within the cabin can have a long-term and damaging effect on hearing."

The non-profit national foundation, based in New York, U.S., and established in 1958, funds research aimed at curing and preventing all forms of hearing loss. Some of the foundation's research has showed that – although decibel levels vary, depending on the type of aircraft, the phase of flight, the seat position a crewmember occupies, the altitude and the weather - cabin noise levels in a "typical jet-engine airplane at takeoff" were



measured between 95 dB and 98 dB and in a turboprop airplane at about 110 dB. An older jet airplane can have cabin noise levels during cruise flight of more than 90 dB and slightly more if the airplane has tail-mounted engines, he said. (The Boeing co. has measured noise levels on the flight decks of Boeing aircraft at between 72 dBA and 76 dBA during cruise flight. The dBA measurement is based on a scale weighted toward sounds at higher frequencies).

"The [flight attendants] of many jet airliners spend a considerable part of their time in the noisiest part of the aircraft, i.e. the galley, which is often at the rear," Goldstein said.

In some countries, including Canada, occupational safety and health regulations for aviation workers are enforced by aviation authorities. Transport Canada, for example, enforces aviation occupational safety and health regulations included in Part II of the Canada Labour Code that limit the noise-level exposure of crewmembers – and passengers to 87 dB during a 24-hour period, whether they are in the air or on the ground. If noise levels are higher, hearing protection must be worn.

In the United States, when an aircraft is in operation – that is, whenever a flight crewmember or cabin crewmember is on board, even if the aircraft is on the ground and the engines are not operating – FAA regulates noise exposure for crewmembers. U.S. Federal Aviation Regulations Part 25.771 requires that “vibration and noise characteristics of cockpit equipment may not interfere with safe operation of the airplane.”

Noise exposure for most other workers in the United States (including individuals working in or around aircraft that are not in operation) is regulated by the U.S. Occupational Safety and Health Administration (OSHA), which requires employers to administer hearing conservation programs for workers whose noise exposure equals or exceeds an eight-hour time-weighted average of 85 dBA. Hearing-conservation programs include monitoring noise exposure and providing “suitable hearing protectors” for workers whose exposure exceeds the allowable limit.

Gary Davis, assistant manager of the FAA Air Transportation Division, said that FAA officials are considering proposing new rules to establish hearing-conservation programs that would be based on noise-exposure limits established by OSHA but with modifications that would take into consideration the fluctuating noise levels in aircraft that may expose crewmembers to high decibel levels for periods of about 15 minutes at a time.

On the flight deck, pilots are exposed to multiple sources of noise from aircraft powerplants, transmission systems, propellers, rotors, hydraulic and electrical actuators, cabin air conditioning systems and air pressurisation systems, cockpit advisory systems and alert systems, and communications equipment.

Two techniques are available to pilots for reducing the amount of cockpit noise that enters their ears: passive attenuation and active attenuation.

Passive attenuation involves imposing a physical barrier against the sound waves by using earplugs or full-cup headsets. Earplugs provide noise reduction of between 5 dB and 30 dB for frequencies below 1,000 Hz and between 30 dB and 40 dB for frequencies higher than 1,000 Hz. Passive-attenuation headsets provide noise reduction of less than 20 dB for frequencies below 1,000 Hz and noise reduction of between 25 dB and 40 dB for frequencies higher than 1,000 Hz.

A 1998 report by the Air Line Pilots Association (ALPA), about a study of various types of sound-attenuation equipment said, "The most important aspect of passive noise attenuation. . .is that headsets alone provide little protection in the lower ranges of the frequency spectrum."

Active noise reduction (ANR) headsets, however, are effective in lower frequencies and work by using a small microphone near each ear to measure ambient noise. Electronic circuitry determines the prevalent lower frequency of the ambient noise, and the headset generates an "opposite phase signal of the same magnitude" and sends that signal to a speaker in the earcup. When the new signal is combined with the ambient noise, they cancel each other. The result is silence.

The ALPA study, which included assessments of several types of ANR headsets by pilots for regional airlines and major airlines, said that the regional airline pilots preferred headsets that attenuate as much noise as possible, and pilots for major airlines preferred smaller headsets that allowed for easier communication on the flight deck while also attenuating, low-frequency noise.

"In a quieter cockpit without a 'hot' intercom system [a voice-activated system that does not require other action, such as depressing a button on the control yoke], these pilots seemed to view the bulkier headsets as providing too much attenuation," the ALPA study said. "Several pilots commented that they had to pull the earphone off of one ear just 'to hear the requests of the other pilot, thus defeating the purpose of the headset."

Ydalus said that he and his B-737 copilots use headsets to listen to all communications and transmit with a boom microphone.

"We remove the earcup on the side [of the headset] towards the other pilot for intercockpit communication," he said. "In order to use the interphone, I have to press a button on the yoke in order to transmit with my boom [microphone], a very . . annoying procedure. Using this, you will not achieve a normal conversation."

Curdt-Christiansen said that the use of a single earphone is "common practice" among pilots - especially those in aircraft without intercoms who want to "keep the other ear free for conversation", even though specialists have encouraged full use of headsets for hearing protection.

Andrew Ursch, aviation product manager for the David Clark Co., which manufactures aviation headsets and intercoms, said that, even when pilots are flying aircraft with relatively quiet flight decks, "there's still enough ambient background noise . . .to have long-term hearing damage."

Ursch said that the most effective way to address the problem is to combine the use of an ANR headset and an intercom, which allows pilots to "turn the volume up so they can hear better." As they adjust the volume of the intercom, the ANR headset cancels ambient noise, he said.

Hearing specialists recommend intensified efforts to educate pilots, flight attendants and others about the risks of noise induced hearing loss, along with the use of hearing-protection devices, including earplugs and headsets. Even for those who already have experienced hearing loss, use of protective equipment should prevent further damage.

Types of Hearing Loss

Hearing loss can be caused by various conditions, including:

Exposure to loud noises (above about 85 decibels) destroys the hearing receptors, hairlike sensors in the inner ear, by breaking or being the receptors and making them less efficient. This type of hearing loss often is accompanied by tinnitus, a ringing or hissing sound that originates in the ear. Noise-related hearing loss can be prevented by wearing earplugs or ear muffs. Hearing aids often are useful for people with severe noise-related hearing loss;

Age-associated hearing loss, which appears to be related partly to the extent of an individual's lifetime exposure to noise, causes sensorineural hearing loss, that is, hearing loss associated with damage to the inner ear, auditory nerve or auditory nerve pathways in the brain. Age-associated hearing loss begins after age 20 and affects men more often than women. Hearing aids often are prescribed;

A mechanical obstruction in the ear canal or the middle ear, such as an accumulation of ear wax in the ear canal or an accumulation of fluid in the middle ear, can block conduction of sound, causing conductive hearing loss. The condition can be treated by removing the wax or draining the fluid;

A hereditary problem, exposure to loud noise, an infection of the inner ear, specific medications and specific diseases (such as Meniere's disease, which also is characterised by tinnitus and dizziness) can damage the inner ear, auditory nerve or auditory nerve pathways in the brain, causing sensory hearing loss. Treatments vary;

Brain tumors, infections, brain disorders and nerve disorders (such as those caused by strokes), and specific hereditary diseases (such as Refsum's disease, in which tissues accumulate phyantic acid, a product of fat metabolism) can damage nerves, causing neural hearing loss. Treatments vary; and

Demyelinating diseases (which destroy the nerve covering) can damage auditory nerve pathways in the brain, also causing neural hearing loss.

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