focus

ON COMMERCIAL AVIATION SAFETY

WINTER 2004

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

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Front Cover Picture: Rolls-Royce Trent 900 engine which will be fitted to the Airbus A380,
picture courtesy of Rolls-Royce plc

Naval Ramp Operations – A Lesson in Ramp Safety

During September 2004 I had the good fortune of visiting HMS Invincible as she operated in the North Sea working up several squadrons of Harriers before their deployment to Afghanistan.

The primary objective of the visit was to try to get first hand understanding of the flight deck operation and in particular the way in which the aircraft were handled on the flight deck with regard to safety.

There is very little room on the flight deck for parking and manoeuvring the fixed wing aircraft which are parked within feet of one another. Before a launch (usually of 2 or more aircraft) the aircraft are carefully moved about the deck to ensure that those that are to be launched are in the correct position and sequence for the launch.

Any unserviceable aircraft are moved to a position where the repair can be effected without disruption to the flying operation. Apart from when the aircraft are taxiing to the launch position all aircraft movement is done using a heavy tractor. Vigilance and supervision are the key factors during this operation as damage to the aircraft whilst manoeuvring in such a confined space could easily occur.

For the launch the aircraft are taxied to the launch position under their own power and after a final check are launched. Two or four aircraft are launched in as many minutes.

The activity of the flight deck crew is not frenetic as one would imagine. This is measured and purposeful with a sense of urgency. Everyone knows what they have to do and does it according to the procedure. The system works like a well greased mechanism. In no time at all the aircraft are launched and the flight deck then prepared to recover the aircraft.

The recovery of the aircraft which often return with just sufficient fuel is equally as well organised. To lose an aircraft in the sea through lack of fuel would be unacceptable. As soon as the aircraft lands it is manoeuvred out of the way of the following aircraft and shackled to the deck.

Once all the aircraft have been recovered the normal turnaround repairs, inspections, refuelling and positioning is completed as quickly as possible.

So how is all this activity and work carried out without damage to the aircraft?

Firstly all aircraft movements are well planned taking into consideration aircraft serviceability. This enables the Landing Deck Officer (LDO) to position the aircraft in the correct position and sequence for the following launch.

The aircraft movement and preparation for flight is extremely well organised. Vigilance of the team is very important during aircraft movements and any difficulty is immediately communicated to the LDO.

Leadership on board the ship was evident at all levels. At times subtle, but always present. Nowhere was this more evident than on the landing deck.

Control of all the activities was paramount. Nothing happened on the landing deck without the LDO's knowledge and approval. It was his job to conduct these operations safely, just as a musical conductor conducts an orchestra.

The spirit of co-operation, teamwork and attention to detail was in evidence everywhere. The landing deck is no place for experimentation, selfishness or lack of discipline or self discipline. In addition those involved in the work were happy and took considerable pride in their work.

The lesson became very clear to me. All the elements of good management – planning, leadership, organisation and control – were in evidence. These elements liberally interspersed with good training, a high standard of discipline and self discipline and coupled with a good understanding of the necessity for teamwork made up the ingredients necessary for the safe operation of the landing deck.

Perhaps commercial operators could learn from this. The absence of the above mentioned elements of good management, training and discipline are sometimes in evidence on the ramps of some commercial airports. By improving the way the turnaround of commercial aircraft are managed on the ramp could save some operators a considerable amount of money. Recent research in this area estimated the value of ramp damage to commercial aircraft to be in the order of 4 and 6 billion US Dollars annually.

Improving Communication

The recent UKFSC Seminar looked at communication and the difficulties some companies may have. This year, we invited other industries to come and talk about their experiences and ways that they try to deal with communication difficulties.

It was apparent that the aviation industry, and particularly in the UK, has been making great strides in this important area of Flight Safety. We have achieved a high level of safety awareness throughout the industry, but, as I remarked at the end of the Seminar, let's not get too smug – there is still plenty to do.

Safety awareness is not always enough – there is no point in knowing an accident may happen if we do nothing about it.

The route to achieve good accident prevention programmes and safety management systems has to start from the top. In any industry, if the workers know that the bosses believe in their cause, the incentive to achieve is far greater, and aviation is no different.

Maintaining an effective and pro-active safety department takes time and money – the two things that are at a premium in the industry and not easily available! The majority of aviation companies in the UK have safety strategies in place but are they there because of the company culture or because of Regulation? I would like to think that safety culture is the driving force.

The quest in the industry for better returns using fewer resources is an understandable attitude, after all, the more money we make, the safer and more secure our jobs. This must, however, be balanced against a strong safety culture throughout the company. A little money, well spent, may save millions in the future.

Have I got your attention company accountants?!

01 Jan 05 sees the mandatory introduction of Flight Safety Monitoring (FDM) in the UK for all commercial aircraft over 27 tonnes. For those companies who do not have FDM, this probably comes at a time of tight budgets and limited revenue. It should, however, if used sensibly (and sensitively!) pay for itself and add considerably to the safety system. For the accountants, let me offer you the incentive of crews following Standard Operating Procedures (SOPs) more carefully; thus correct landing speeds will reduce brake and tyre wear, as well as reduced engine component failure and economical fuel burns with accurate cruise speeds. This, of course, is not the only way that money can be saved. Proficient investigation of incidents, recommendations for changes to SOPs and training, poster campaigns and annual refresher training, are a small part of what can be done to add to a sturdy safety system.

So who can save you a lot of this cash? Probably your Flight Safety team.

I make no apologies for repeating myself from previous columns when I say that the temptation to cut safety budgets should always be avoided. Inevitably the balance between cost and safety has to be a compromise that will keep all sides happy, but this can be achieved through sensible planning and reasonable requests (not demands!). The safety manager with the "must have now" attitude is guaranteed to turn the company's money tap off!

"We haven't had an accident so we must be safe" is, thankfully, not a phrase we hear too much of in aviation these days, but perhaps the thought may still occur to some. Is this the case for you, or have you just been lucky?

UK FLIGHT SAFETY COMMITTEE OBJECTIVES

- To pursue the highest standards of aviation safety.
- To constitute a body of experienced aviation flight safety personnel available for consultation.
- To facilitate the free exchange of aviation safety data.
- To maintain an appropriate liaison with other bodies concerned with aviation safety.
- To provide assistance to operators establishing and maintaining a flight safety organisation.

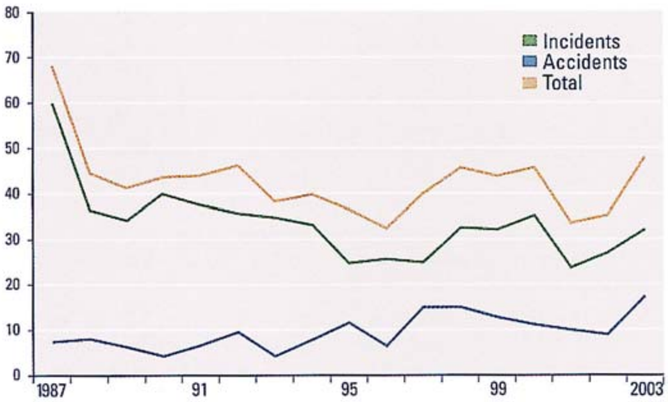
Ramp Accidents and Incidents Constitute a Significant Safety Isssue

by Robert Matthews, Federal Aviation Administration (United States)

The airport ramp can be an intensely busy and confined space where accidents impose substantial costs on the industry. A recent analysis of ramp events highlights procedural and training issues that can only be properly addressed with a change in organisational culture.

A recent analysis of ramp accident and incidents involving U.S. air carriers over a 17-year period reveals that occurrences on airport ramps constitute a significant safety issue that costs airlines over U.S $3 billion annually. According to an analysis of data from several sources ramp accidents persistently account for 20 to 30 percent of all air carrier accidents in the United States.

The analysis of ramp events reported during the 1987-2003 period reveals a total of 18 fatalities and 149 injuries, of which 55 were serious. More than 700 events involving 880 aircraft were studied, including 161 accidents in which six aircraft were destroyed and 132 aircraft were substantially damaged (see accompanying figure).



A total of 727 ramp events over a 17-year period were studied. The analysis included 161 accidents resulting in 18 fatalities and 55 serious injuries. Damage to aircraft included six hull losses.

The analysis covered approximately 2.5 percent of all events reported during the 17-year interval (i.e. about one in 40 events). Nevertheless the analysis is thought to include a high percentage of the more serious occurrences involving aircraft. Some 75 percent of the data was obtained from the U.S. Federal Aviation Administration (FAA), and just over 20 percent from the U.S. National Transportation Safety Board (NTSB). Airclaims was the source for about 4 percent of the data.*

The principal causes of the ramp events are failure to follow procedures and inadequate training of ground or flight crew. Corrective action is typically inexpensive but difficult to implement effectively as it calls for change in organizational culture.

Ramp operations

In the United States, most airport operators delegate much of the responsibility for ramp safety to air carrier tenants through local leasing agreements or other formal mechanisms. Generally, larger air carriers have their own ramp departments for activities such as baggage handling, marshalling, aircraft towing and pushback. At stations where a carrier has a limited presence, these services may be provided under contract by other carriers or by airport service companies. Specialized activities such as aircraft fuelling, cleaning, catering and lavatory service often involve additional contractors.

These various activities mean that an assortment of aircraft, vehicles, equipment and people are vying for space on the ramp. The ramp area also accommodates airport operations and maintenance staff, airport police, construction workers, airline and airport engineers, planners, and regulatory and security personnel. All these people must carry out their tasks, as very large aircraft move to, from and within confined spaces. The ramp can be a complex, confined and intensely busy area.

Fatalities and injuries

Most of the ramp events involving fatalities or serious injuries occurred during departure and a disproportionate number of fatalities and serious injuries involved turboprop aircraft. While accounting for 30 percent of departures during the study period, turboprops were involved in half of the 18 fatalities and 38 percent of the serious injuries.

The 18 fatalities included 15 ground workers, two passengers and one flight crew member. As the accompanying table illustrates, ramp workers are at greater risk of serious injury or death.

Of the 15 fatally injured ramp workers, eight were struck by rotating propellers, most often at night. In all 15 cases, procedures either were inadequate or, more frequently, not followed. In some cases lack of training was a contributing factor. Propeller strikes also accounted for five serious injuries to ramp workers.

While most of the serious injuries occurred to ramp workers, airline passengers were seriously harmed in 13 ramp events, cabin attendants in five and a pilot on one occasion. Of the 13 events in which there were serious injuries to passengers, nine involved turboprops. In most cases, passengers either fell from or slipped on airstairs while desembarking or boarding, although in one case a cabin attendant closed the cabin door prematurely and broke a passenger’s hand. In two instances surface vehicles struck aircraft as passengers were boarding, causing them to fall.

A primary factor in most passenger injuries was the failure of ramp personnel to follow proper procedures. Among the cases reviewed passengers were injured because they used airstairs without proper handrails, lost their footing on auxillary steps placed improperly at the bottom of the airstairs, or were left to board or disembark from aircraft without being monitored. However, passenger negligence also played a role. Injuries occurred to passengers who were boarding or disembarking while carrying too many bags or who declined assistance offered by airline staff.

Of the five occurrences in which cabin attendants were seriously injured, four involved opening cabin doors at the gate. In one case, an overly helpful flight attendant fell after opening the aircraft door to retrieve a stuffed animal dropped by a child upon boarding.

The lone serious injury to a flight crew member involved a collision with an employee bus as the aircraft taxied. The NTSB cited both the bus driver and the pilot for not following procedures. The bus driver ran a stop sign at the same moment that the pilots were focused on completing their paperwork.

As highlighted above, the greatest number of serious injuries were suffered by ramp workers. Generally, injuries to this group were more severe in natue and included loss of limbs and severe crushing injuries.

Serious injuries to ground workers almost uniformly involved inadequate ramp procedures or a failure to follow procedures. Just two of the serious injuries to ramp workers did not involve ramp procedures. In both cases faulty equipment was to blame. Use of inadequate equipment, such as headsets with short cords restricting movement, can also be cited as a safety concern.

Four of the injuries to ramp workers involved flight crews who did not follow proper procedures. On two occassions, flight crews failed to follow braking procedures on pushback. In two other cases, flight crews did not follow the proper engine-start procedure, resulting in excessive jet blast. All four of these events led to severe injuries, damaged equipment, and in one case, a fire at the gate in which the aircraft was destroyed.

However, over 80 percent of the injuries to ramp workers were caused by the workers’ failure to follow proper procedures, which in many cases could be linked to inadequate training. These occurrences encompassed a broad range of ground activities.

The pervasive issues of abrogated procedures and inadequate training suggest that the industry culture underlying ramp operations is flawed. Safety improvements can result from conscious efforts to change organizational culture. Such efforts assume at least the following: (1) we can come to understand and articulate the existing culture; (2) we can identify the direction in which the culture should change and the characteristics that it should adopt and (3) we can intervene and actually bring the organization to the prescribed set of values and behaviours. These are not easy tasks.

An analysis of ramp ocurrences indicates that most fatalities or serious injuries occur during departure.

Nevertheless, commonly repeated procedural failures imply a cultural value that defines ramp events as just one of the inherent costs of doing business. While a treatise on organizational culture is clearly beyond the scope of this article, it is vital to understand the role culture plays in the effectiveness of any safety programme.

A ramp worker lost his life while preparing to push back this DC-9 in December 2003. The tractor's operator left his seat to set the tow bar for attachment to the tug. On return, his foot accidentally hit the accelerator and the tug jumped forward and struck the aircraft radome, fatally pinning the driver. The driver had failed to set the parking brake before leaving the tug.

Types of events

While fatalities and serious injuries sometimes result from ramp accidents, the large majority of occurrences entail minor injuries and minor damage to aircraft and equipment. Several classes of events are described below.

The most common scenario by far involves a single aircraft and a surface vehicle. Of the 727 events studied, 40 percent involved collisions between aircraft and ground vehicles. Among these collisions, 15 percent resulted from flight crew errors such as failing to follow marshalling instructions or setting brakes.

Another 15 percent of the collisions were caused by poor ramp conditions such as ice and snow or congesion caused by non-essential equipment or by the use of inappropriate equipment. In most of these cases, the carrier was responsible for the condition of the ramp area. Still another 5 percent involved inadequate or non-existent company procedures.

A significant majority – nearly two-thirds – of all ramp accidents and incidents involved procedural and training issues. By far, the most common errors were caused by marshallers who did not ensure that the area behind or adjacent to a moving aircraft was clear of obstruction, or who failed to follow communications procedures or use proper chocking methods.

INJURED PARTY	FATALITIES	SERIOUS INJURIES	MINOR INJURIES
Passengers	2	13	30
Flight Crew	1	1	2
Cabin Attendants	0	5	7
Ground Crew	15	36	55
Total	18	55	94

Analysis of 727 ramp events: injuries at U.S. airport, 1987-2003

Aircraft-to-aircraft contact in the ramp area, though costly in terms of repair, rarely led to personal injuries or severe aircraft damage. Of the events studied, 41 aircraft sustained substantial damage and 245 received minor damage. No hull losses resulted from collisions between aircraft.

Improper marshalling procedures accounted for half of all occurrences of this type, and procedural errors by flights crews accounted for one-third. Other common factors were poor ramp conditions and inadequate company procedures. Untrained personnel were used to marshal aircraft, and attempts were made to operate from gate areas that were not adequately designed. Fifty percent of the collisions between aircraft occurred on arrival, 40 percent on departure, and 10 percent during repositioning of aircraft by maintenance personnel.

Aircraft striking jetways was another costly event and represented 8 percent of reported ramp events, with most caused by marshallers being out of position, misjudging clearance, or failing to communicate. However, other causes cited for these collisions include procedural errors by jetway operators, flight crew errors and ramp conditions, especially the presence of snow and ice. Inadequate company procedures were an issue in many of these cases.

Jet blasts were the next most common occurrence, accounting for over 5 percent of all ramp events. Repositioning by maintenance personnel accounted for several cases, but most involved flight crews and were evenly split between arrival and departure. The majority of events caused by the latter group were attributed to improper flight crew procedures. A relatively modest number of cases involved ramp workers. Inadequate company procedures were also a factor in several cases.

Jet blast damage can be significant. The jet blast events identifed in the analysis resulted in damage to terminal buildings, nearby aircraft, jetways, hangars, ground vehicles and carts.

Aircraft striking objects such as terminal buildings, construction equipment and light poles accounted for almost 13 percent of the ramp events. Three-quarters of these events involved procedural and/or traininig issues involving ground workers. Most events were attributed to marshallers and wing walkers, but baggage handlers, tug operators and truck drivers were also included in this group. Improper flight crew procedures were a factor in 30 percent of the cases. Poor ramp conditions, flawed equipment and inadequate company procedures acounted for the remainder.

Financial costs

The ramp events identified in the analysis averaged direct costs of about U.S. $600,000. This figure is much higher than most estimates of average cost, but is reasonable considering that NTSB and FAA databases are skewed to the more severe outcomes.

Direct costs are fairly straightforward to calculate, and include the cost of injuries, damage and repairs to aircraft, structures, vehicles and other property. However, these sums are modest when compared to indirect costs such as the network costs of cancelled flights, extensive down-time for aircraft, and leasing of replacement aircraft.

Modest estimates put indirect costs at three to five times the direct cost. Qantas Airways has estimated ratios of 7:1, while other estimates go much higher. On the conservative side, with an assumed ratio of just 5:1, the total cost of ramp accidents and incidents exceeds U.S. $3 billion per year in the United States alone.

While this is a seemingly substantial figure, it is very likely to be on the conservative side.

Conclusions

Ramp areas can be intensely busy, confined spaces, in which a variety of aircraft, vehicles, equipment and people are concentrated. Consequently, ramps pose real safety threats for passengers, crew, and ground workers, Accidents and incidents on the ramp occur frequently and impose substantial costs on the industry.

Nearly all 727 ramp accidents and incidents studied were caused by procedural failures of one sort or another, with inadequate training a contributing factor. Procedural errors were most common among ramp workers, but improper procedures on the flight deck were involved about 25 percent of the time. Ramp conditions, especially ice and snow, and inadequate company procedures, were other common factors. These causal factors suggest the need for a fundamental change within the industry.

What can be done about ramp accidents and incidents? Advocating better procedures, better training and cultural change often is no more useful than advising that "everyone needs to be careful." Yet, safety improvements can be made provided that companies sustain the effort over time.

Air carriers are not the only organizations that will need to take some action if the ramp is to be made a less hazardous and less costly place. Airport authorities and aircraft service providers must also recognize the need for action and must develop the means to improve the safety of their operations.

More accurate reporting of events and the development of a more reliable database would enable better analysis and, presumably, better understanding of the characteristics of these events and the corrective actions required. This is an issue that is best addressed by regulatory agencies and governments.

** When data from the U.S. Occupational Safety and Health Administration (OSHA) for a nearly identical 16-year study are taken into consideration, the number of fatalities and serious injuries rises by nine and 75, respectively. OSHA data concerns events where there are no crew members on-board the aircraft or there is no intention for flight.*

Robert Matthews is the team leader for Safety Analysis in the Office of Accident Investigation at Federal Aviation Adminstration (FAA) headquarters in Wahsington, D.C. The views expressed in this article represent those of the author and not necessarily the views of the FAA. This article is an abbreviated adaptation of a paper presented by Dr Matthews to the International Society of Air Safety Investigators (ISASI) Seminar held in Washington, D.C. in August 2003.

Reprinted with acknowledgement to ICAO

Disruptive Behaviour on Board UK Aircraft: April 2003-March 2004

Background

1. At the request of the Department for Transport, UK airlines have since April 1999 reported incidents of disruptive behaviour on board their aircraft to the Civil Aviation Authority (CAA), on a common reporting basis. The CAA has now analysed the data submitted for the year April 2003 to March 2004. This note summarises the outcome. At Annex A is a table comparing key data over the last four years.

Change to Reporting Scheme

2. In order to minimise the burden on airlines and their crews, to focus attention on those incidents which pose actual or potential risks to crew and passengers, and to ensure consistency in reporting, from 1 June 2002 the Department asked airlines to report only those incidents which were likely to be categorised subsequently by the CAA as being "serious" or "significant" The omission of "other" incidents from June 2001 onwards has resulted in a large reduction in the overall number of incidents reported in comparison to previous years.

3. Linked to this change were some minor changes in the criteria used by the CAA to classify "significant" incidents. The result of this is that a few types of incidents which may previously have been classified as "other" are now classified as "significant". This may account for the apparent increase in "significant" incidents and means that a comparison of the "significant" incidents with previous years may not be entirely accurate. However, the criteria for classifying "serious" incidents, which is entirely the responsibility of the CAA, did not change, and comparisons in this category are therefore valid.

Number of Incidents Recorded

4. A total of 696 serious and significant incidents were reported in the year to 31 March 2004, an increase from 648 incidents during the previous 12 month period. The CAA classified incidents according to their actual or potential threat to flight and personal safety, taking into account consequences such as aircraft diversions. Of the 696 incidents reported, the CAA categorised some 668 as significant incidents and a further 28 were judged to be serious. When compared with the previous 12 month period, the number of significant incidents has increased by 9% but the number of serious incidents has decreased by 20%.

5. Over the 12 months to 31 March 2004 no case was reported in which disruptive behaviour by a passenger or passengers contributed to an aviation accident, although there were a number of incidents where the description of events referred to violence against cabin crew.

6. These figures continue to show that "air rage" is not a widespread phenomenon, and that the probability of any individual passenger being affected by an incident of disruptive behaviour is extremely low. However there remains a low level of anti-social behaviour, which on occasions escalates into serious incidents which could pose a threat to the safety of the aircraft and/or its occupants. The Department is also conscious that airline employees working on board aircraft are more at risk of harm than the average passenger by virtue of flying more frequently and the nature of their responsibilities.

The Offenders

7. Some 78% of incidents involved male passengers, similar to previous years. The largest age group involved in the offences were those offenders in their 30s (accounted for 35% of incidents). Approximately a third of incidents involved people travelling alone. Whereas last year 9 incidents involved groups of 10 or more, this year 14 incidents involved large groups of disruptive passengers. About 1% of incidents occurred in business or first class seating, which is lower than previous years.

The Offences

8. The majority of cases reported could be described as general disruptiveness, with verbal abuse either to cabin crew or other passengers occurring in 40% of cases. Between a quarter and a third of all cases involved disobeying airline staff. Smoking restrictions and alcohol were common triggers for unruly or aggressive behaviour, while arguments between passengers often stemmed from domestic disputes,

arguments over allocation of seats, or the effect of reclining a seat on the person behind.

9. Among the incidents categorised as significant, by far the most common misbehaviour remained smoking in the aircraft's toilet. There were also many cases of aggressive or abusive behaviour, of repeated refusal to follow instructions, of intoxication, and of passengers exhibiting signs of personality disorder. Violence was involved in 14% of significant incidents.

10. As in the previous year, the 28 incidents categorised by the CAA as being serious included several in which passengers were acting extremely irrationally and strongly suspected of being, or known to be, under the influence of drugs. Many involved excessive consumption of alcohol and varying degrees of violent, abusive or unacceptable behaviour. There were also a number of incidents involving passenger interfering with smoke alarms and causing a fire risk whilst smoking in toilets.

The Consequences

11. In the majority of incidents a warning of some sort was given to the offending passenger, and the evidence from the reports suggests that the warning was effective in 43% of cases, and ineffective in 34% of cases (in the remainder, the degree of effectiveness of the warning was not reported).

12. In 16 incidents a passenger had to be physically restrained by handcuffs and/or a strap (compared to 6 in 2002/2003 and 16 in 2001/2002), and in a further 4 incidents other forms of restraint were used. There were 4 occasions on which the aircraft had to divert when in the air (similar level to the previous year) and 7 when the aircraft was forced to discontinue taxi or take-off procedures and return to its stand. The reporting procedure covers the time from embarkation to disembarkation. There were 80 incidents reported where passengers were offloaded (either after boarding, after pushback or at a stopover).

13. Since cabin crew would not necessarily know at the time of reporting an incident whether further action was taken, there are no reliable figures on how many incidents led to arrest or other police action. However, police or security attended 185 incidents involving disruptive behaviour on-board UK aircraft during the 12 months to 31 March 2004 (similar to the previous year).

The Contributory Factors

14. Excessive consumption of alcohol and smoking were once again the two main contributory factors to disruptive behaviour. Alcohol was identified or suspected as being a contributory cause in 42% of all incidents. Around 29% of the alcohol related incidents involved passengers drinking their own alcohol and 29% involved passengers drinking alcohol before boarding. The data confirms that drinking prior to boarding often has a knock-on effect on behaviour on the aircraft.

15. Smoking, or the desire to smoke, featured in 275 Incidents (40% of the total). 82% of these incidents involved smoking in the toilets. The latter category of offence implies a degree

of premeditated deception, and poses greater safety risks to the aircraft should a carelessly discarded cigarette result in a fire.

The Context

16. The number of recorded incidents must be seen in the context of the number of flights operated by UK carriers, and the number of passengers carried.

17. During the 12-month period covered by the data, UK airlines operated about 1.1 million passenger flights and carried about 110 million passengers. In this period only 28 serious incidents were recorded. This means that the chance of an individual passenger boarding a flight on which a serious incident took place was around 1 in 40,000, and that only 1 in every 4 million passengers was the cause of a serious disruptive incident. Even extending the calculation to cover all reported incidents, the figures would rise only to 1 in 1,600 and 1 in 158,000[1] respectively. However, the risks to which individual airline employees may be exposed are substantially greater than those facing passengers.

Department for Transport, May 2004

Reprinted with kind permission of Flight Safety Review Issue 5 First Choice Airways

Annex A

Comparison of key data over 4 years

	2000-01	**2001-02**	**2002-03**	**2003-04**
Total incident reports[2]	**1250**	**1055**	**648**	**696**
Severity				
Serious	63	52	35	28
Significant[3]	595	528	613	668
Other	592	475	-	-
Context				
Number of flights per serious incident	17,000	22,000	36,000	40,000
Number of passengers carried per serious indident	1.7 million	2 million	3 million	4 million
Incident details				
Violence involved	139	101	90	106
Violence toward crew	71	49	48	46
Contributory factors				
Alcohol involved	533 (43%)	472 (45%)	271 (42%)	290 (42%)
Alcohol - pre-boarding	198	198	121	85
Alcohol - airline	165	92	63	66
Alcohol - own	214	182	88	85
Smoking involved	408 (33%)	385 (36%)	260 (40%)	275 (40%)
Smoking in toilet	350	306	221	226

[1] It should be noted that some incidents involve more than one culprit.

[2] From June 2002 airlines were asked to report only incidents that were likely to be classed as serious or significant. This impacts the figures for 2002-03 and 2003-04

[3] The rise in 'significant' incidents for 2002-03 and 2003-04 may be accounted for by a change in the classification of certain types of incidents.

Top Ten Causes of Maintenance Mishaps

1. **Failure to follow published Tech Data or local instructions.**
2. **Using an unauthorized procedure not referenced in Tech Data.**
3. **Supervisors accepting non-use of Tech Data or failure to follow maintenance requirements.**
4. **Failure to document maintenance in the AFTO Form 781 or engine work package.**
5. **Inattention to detail/complacency.**
6. **Incorrectly installed hardware on an aircraft/engine.**
7. **Performing an unauthorized modification to the aircraft.**
8. **Failure to conduct a tool inventory after completion of the task.**
9. **Personnel not trained or certified to perform the task.**
10. **Ground support equipment improperly positioned for the task.**

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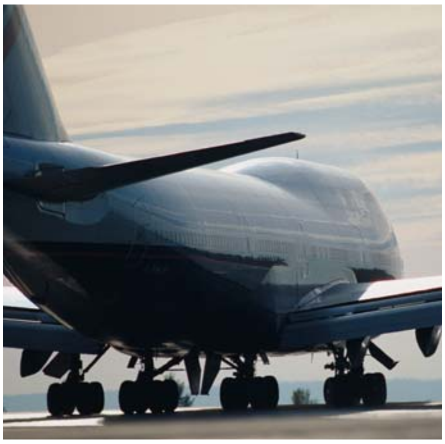
The Secrecy of Safety

by Simon Phippard, Barlow Lyde & Gilbert



"Bringing criminal charges into aviation occurrences resulting from inadvertent operational errors may hinder the development and free exchange of safety information which is essential to improve aviation safety, with a potential adverse effect on it."

Recent years have seen a trend in two particular factors: first an increase in the use and contribution of safety data collection systems and their contribution to flight safety understanding and analysis compared from that gained from accident and incident investigations. Second there has been an increase in the number of occasions on which information gained from accident or incident analysis and safety data collection systems has been used in criminal or disciplinary proceedings against the individuals involved. A recent example of note was the use of an air accident investigation report in the criminal trial of a Japan Airlines pilot. In the event, the captain was found not guilty in connection with a death and injuries caused when the aircraft encountered turbulence.

In a small number of extreme cases there has been considerable tension between the criminal investigation and air accident investigation authorities and their respective responsibilities. Unfortunately those tensions are likely to be at their greatest in the immediate aftermath of a major accident with large scale loss of life when media or political demands for a scapegoat are at their most insistent and the likelihood of an objective determination of the best manner of resolving the situation is perhaps at its lowest.

The 35th ICAO Assembly, which took place in Montreal between 28 September and 4 October 2004, passed a resolution which is designed to secure greater legal protection and confidentiality for information from safety data collection systems, whether obtained voluntarily or under compulsion.

In its briefing for the debate ICAO identified three categories of safety data collection systems: self-reporting, electronic capture (e.g. Flight Operations Quality Assurance programmes) and direct observations (e.g. audit crews observing from the flight deck). These systems, which provide most information into those errors which do not result in an incident, combine with investigations into accidents and incidents to provide a fuller understanding of the threats to safety. Neither type is complete on its own but while there is considerable protection from the possible adverse effects upon individuals of the (often mandatory) processes associated with investigation of unmitigated errors, there is less legal protection, either at ICAO or national level, in relation to the continuous (but often voluntary) process of safety data collection systems.

The background memorandum noted how Annex 13 effectively gives the last word to the authorities responsible for the administration of justice:

"...statements from persons, communications, medical and private information, cockpit voice recorders (CVR) and transcripts, and opinions expressed in analysis of information shall not be made available for purposes other than for accident/incident investigation, unless the appropriate authority for the administration of justice in that State determines that their disclosure outweighs the adverse domestic and international impact such action may have on that or any future investigations."

ICAO's view is that there is insufficient protection in respect of the information available from safety data management systems and without such protection being in place there is a risk of compromising current high standards of safety and the open safety culture. The briefing credits international civil aviation's safety record to the dedication of organisations and personnel to safety and a process of continuous learning, starting from a culture of exchange of information, by which the study of errors leads to the implementation of preventive actions.

The resolution entails two elements that could result in legal changes:

- The Council would develop legal guidance to assist ICAO member states to enact domestic legislation to protect information obtained from safety data collection systems;
- Member states would be urged to examine their existing legislation and adjust them as necessary.

On its face, the resolution will not change an enormous amount because it is limited to such systems (rather than the material available in the more serious incidents and accidents) but does serve to focus attention on what is something of a grey area. The debate is likely to be time-consuming (the briefing reflects work over the period to 2007) so immediate legal changes are some way off. We will follow developments and report to members of the Committee. The issue points up the very difficult balance that has to be struck between the maintenance and advancement of flight safety and the due administration of justice. If, as the ICAO proposal noted, "[it remains undisputed that] the majority of operational errors are inadvertent: well-trained, well-intentioned people make errors while maintaining, operating, or controlling well-designed equipment" there must be a case for creating an environment in which the maximum benefit is drawn from the routine assembly of information and where there is every encouragement for individuals to come forward without fear of repercussion. Nevertheless there are the cases where criminal justice is called for, and the briefing noted that no group of individuals should be above the law. The present debate is unlikely, for the reasons identified above, to cover this aspect directly but the principles should be of equal application to more serious cases.

Peer Intervention

In the Summer issue of FOCUS the detail of the Railways and Transport Act 2003 was highlighted and its possible impact on flight crew explained following the introduction by the police of evidential breath testing for alcohol. Most States in the world have adopted the .2 pro-mille limit, but unless you are teetotal it may be prudent to check local laws. There are a few States where the limit is a more draconian zero, country information can be found on the BALPA website www.BALPA.org flight safety section.

Flight Crew are professionals and as anticipated, the implementation of the Act, in April 2004, has brought with it very few casualties. The few that there have been, almost without exception were the result of the morning after the night before, individuals just not realising quite how long is required to process alcohol through the body system. Operators cannot tolerate such stigma, with the media keen to paint a lurid picture of 'drunken' pilots falling up the aircraft steps, so invariably a positive result will lead to resignation and long term loss of employment. BALPA members advise that when they are operating the next morning they keep clear of alcohol the night before rather than risk an expensive misjudgment, incidentally a policy that most have employed throughout their careers regardless of the new Act.

Alcohol is a problem in society and aviation is not immune. There are individuals who experience difficulty with alcohol, BALPA believes that anyone who takes an alcoholic drink in proximity to duty needs help and there we look to colleagues to help fellow colleagues.

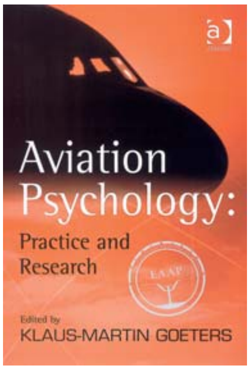
The tried and tested solution from the US. is peer intervention, where critical support, treatment and rehabilitation, take preference over punishment. BALPA does not support random testing - it is unlikely to identify a problem user, but rather the introduction of a joint operator / BALPA driven programme where Pilot can help fellow Pilot identify and beat the problem. This programme has already been fully embraced by one UK Operator, with others indicating that they are also about to implement the programme. It has the support of the Government and the CAA and it is BALPA's goal to further develop the scheme throughout the UK industry. The programme is run by Operators along similar lines to any properly organised FDM programme as far as the confidentiality issue is concerned. The basis of Peer Intervention is that a committee of both peers and managers confronts a problem drinker, premised on the sound evidence that employees will NOT allow their colleagues to embrace a problem, which threatens their safety or the safety of the public. All members of the team will be specially trained to deal with the issue of alcohol as well as drug abuse.

During 2005, dates will be made available soon, BALPA intends to run a Symposium for Operators in conjunction with the DfT and the CAA to assist Operators in introducing this initiative into their organisation structure. This will be followed up by BALPA with training sessions for those involved in running the scheme.

Details of the scheme and a suggested outline draft agreement can be obtained from flightsafety@BALPA.org

Book Review

Aviation Psychology: Practice and Research



Edited by Klaus-Martin Goeters

(0 7546 4017 5)
Hardback £55.00

In the well established aviation system, the importance of sound human factors practice, based on good aviation psychology research, is obvious from those incidents and accidents resulting from its neglect.

This carefully structured book presents an up-to-date review of the main areas in the field of Aviation Psychology. It contains current thinking mainly from Europe, but with input from Australia and North America, from specialists involved in research, training and operational practice.

Spanning six parts, the book covers: Human Engineering, Occupational Demands, Selection of Aviation Personnel, Human Factors Training, Clinical Psychology, Accident Investigation and Prevention.

Looking at the six parts – in human engineering, the reader learns about human-centered automation as well as human factors issues in aircraft certification. Results derived by job analysis methods are presented in the next part and serve as basic information in the design of selection and training programmes. In selection, computerised testing or behaviour-oriented assessments are challenging approaches for personnel recruitment. Cost-benefit analyses in selection reveal convincing results, enabling organisations to save huge amounts of inappropriate training investment by the application of proper selection tests. The NOTECHS method is described which helps to assess CRM capabilities in training and can also be used to measure training effects in systematic validation studies. Although operational personnel in aviation are usually able to cope with stress more efficiently than other occupational groups, individual problems might develop as reactions to traumatic influences. Either a psychological evaluation or a proper treatment or both is then required as described in the 'Clinical Psychology' part of the book.

About the Editor

Klaus-Martin Goeters (M.Sc. and Ph.D. in Psychology) has been Head of Department of Aviation and Space Psychology at German Aerospace Center (DLR) in Hamburg, Germany since 1986. His professional activities include research on living and working under confinement (underwater habitats, spaceflights), psychological selection of operational personnel (pilots, air traffic controllers, astronauts), transfer of psychological tests to different cultures and the design and evaluation of non-technical skills training. He teaches at the University of Hamburg. He is Board Member of the European Association for Aviation Psychology. Besides numerous articles and technical reports he is the editor of Aviation Psychology: A Science and a Profession

Levelling Off

by Bruce Hales-Dutton - National Air Traffic Services (NATS)

For years it's been hailed as the next big thing in air traffic technology, the key to unlocking a treasure trove of information for controllers. Now it's about to be put to the test. Mode Select (Mode S) is coming into operation.

After consultation with the industry, the Civil Aviation Authority has decided that Mode S should replace current secondary surveillance radar (also referred to as Mode A/C radar), a concept dating back to the 1940s and the military Identification Friend or Foe (IFF) system. There are two levels of Mode S surveillance: Elementary and Enhanced. Both provide greater integrity of data than the current system by practically eliminating false responses and garbling at the radar head, particularly in busy airspace such as stacks. Additionally, the Enhanced level provides the capability to down-link extra data from the aircraft cockpit.

Mode S will be introduced in two stages. In the first, Mode S Enhanced Surveillance, becomes mandatory in the London Terminal Manoeuvring Area (TMA) and other areas of UK controlled airspace from 31 March 2005. In the second stage, the use of Mode S Elementary Surveillance becomes mandatory in all remaining areas of airspace in 2008.

For National Air Traffic Services (NATS) it can't come too soon. The UK air traffic services provider sees Enhanced Mode S as a significant development in the campaign against level busts which it launched nearly a decade and half ago.

The potential for Enhanced Mode S to reduce level busts comes from its ability to provide an indication of an aircraft's vertical intentions. The flight level entered by the crew into the aircraft's flight management system can now be down-linked and displayed to controllers. Using this 'Selected Flight Level' controllers will be able to confirm that the aircrew have responded correctly to their vertical clearances. Martin Southall, NATS R&D project manager, explains: 'If the pilot has correctly read-back the height figure given by the controller but incorrectly entered it into the autopilot the controller can now spot that.'

NATS has also developed an automated tool to help controllers. The vertical stack list uses the high integrity Mode S data to provide controllers with information on the aircraft under their control in a stack through an on-screen window. The controller can continuously see the call-sign, flight level and selected flight level of the aircraft. So while labels may be overlapping on the main radar display, the information will be clearly displayed in the vertical stack lists.

NATS sees this as a positive step forward because many level busts happen when aircraft are in holding stacks. Indeed, its figures show that nearly half of all UK incidents happen in the London TMA. This is hardly surprising because it represents some of the world's busiest and most complex airspace, used by traffic flying to and from airports like Heathrow, Gatwick, Stansted and Luton.

The concept and infrastructure to take advantage of the new technology have been developed by NATS over the last two and a half years. During three weeks of real-time exercises at NATS' Hurn facility the Heathrow approach functionality was simulated together with all other associated traffic. Level bust causal factors within a Mode S environment were simulated and the potential to mitigate against level busts was demonstrated.

The controllers involved considered the new human-machine interfaces (HMI) simple and intuitive to use and found they were able to spot level discrepancies earlier and easier. All West Drayton controllers will see the Mode S information displayed on their target labels from day one but it's the Heathrow approach controllers who will be the first to use the vertical stack lists. Those handling Gatwick traffic are scheduled to be next. NATS is now formulating a plan to train the 300 or so controllers at the London Terminal Control Centre at West Drayton in the use of the new technology.

Enthusiastic though it is about the potential of the new technology to cut the number of level busts, NATS is keen to ensure that expectations are not raised unjustifiably high. Limitations remain with the new technology and NATS is keen that it should not be considered as the only answer to level busts. For example, there's little the technology can do currently if the crew have made a mistake in setting their altimeter.

Mode S joins an ever-expanding array of technology, which now includes Separation Monitoring Function (SMF) and Short-Term Conflict Alert (STCA). SMF records events in which separation is eroded by more than a specified amount. This allows the more serious losses of standard separation to be identified quickly so that incidents can be investigated while the events are still fresh and the lessons rapidly absorbed. It also gives confidence that the overall rate of reported level busts remains constant relative to those involving loss of separation.

STCA is based on the processed radar pictures controllers use. If the computer algorithms determine that two aircraft are in potential conflict it alerts the controller by flashing the relevant symbols on the screen. A second-stage alert goes off when the potential for conflict is judged to be greater. Airborne technology is also playing a part. The most modern aircraft feature better methods of altimeter alerting and some airlines have experienced a significant reduction in level busts due to mis-setting following the phasing-out of older types.

But NATS is not pinning all its faith on technology. Raising awareness among the international aviation community is also considered important. Since 1990 when NATS became one of the first agencies to collect and analyse data on level busts it has assembled compelling evidence on causal factors.

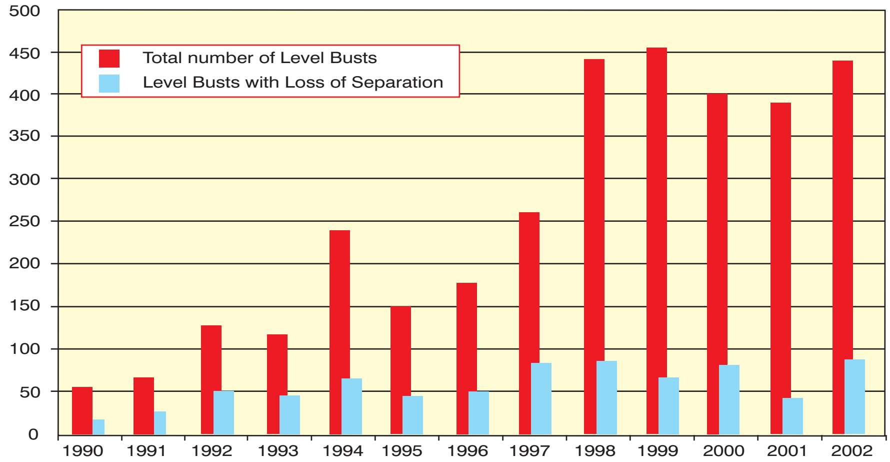


Chart 1: the Scale of the Problem (based on CAA data)

This evidence has prompted the Level Bust Working Group (see box) to make a number of recommendations. In addition to promoting the best use of technological tools for controllers these have included the employment of improved phraseology as well as policy recommendations such as looking again at the transition altitude in the UK.

But one of the most powerful solutions is considered to be working with industry. Many airlines have already given much time and resource to helping NATS and before it the Civil Aviation Authority (CAA) to address the issue. NATS believes recognition of the problem represents a key defence, hence the concentration on raising awareness.

The latest phase of NATS's campaign, called Level Best, opened in autumn 2002. There's also a dedicated website, levelbust.com, which also features a feedback page. NATS hopes that many pilots and controllers will by now have seen the Level Best presentation and the momentum is being maintained this year with a video and CD-ROM package which has been sent to over 300 aviation companies for use as a training tool. It lasts about 25 minutes and gives an overview and an insight into the ATC side of the level bust event.

Alex Bristol, manager ATC at Farnborough Airport and former campaign team leader, puts it this way: 'It's 25 minutes well spent. We'd like as many people as possible to see the video. Spreading the message is the key to success.'
This represents a simplification of the work done to identify the major causal areas. The total of factors is greater than 100 per cent as many incidents have more than one cause.

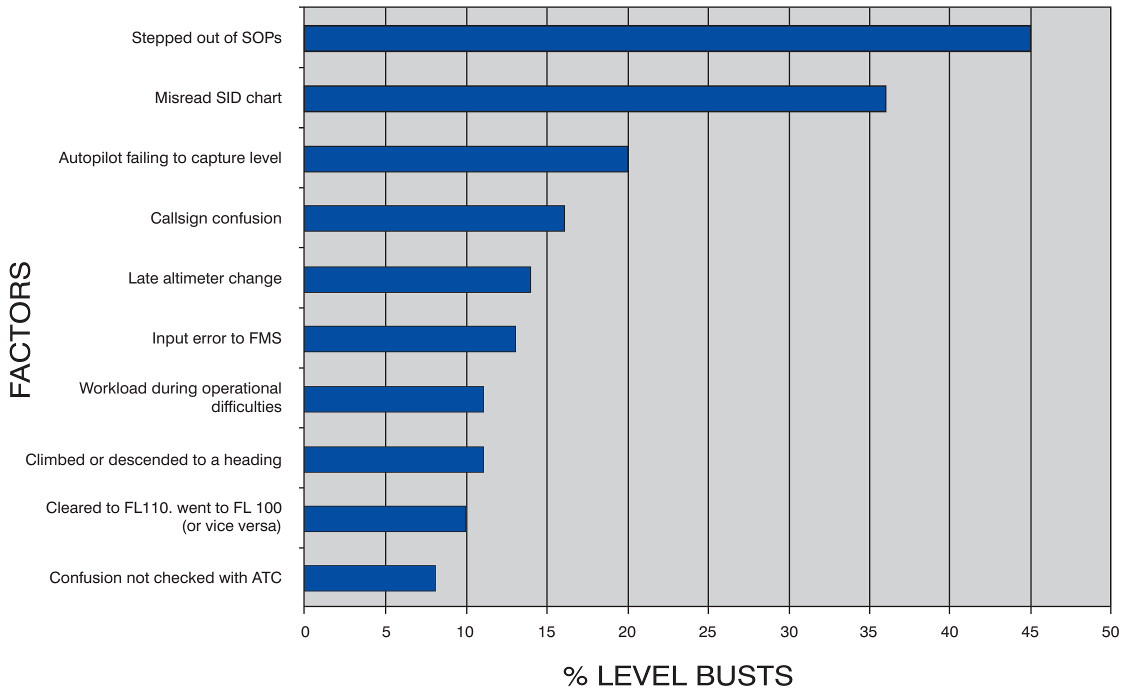


Chart 2: the cause of level busts

Stacking up Trouble

It was a tense time for the trainee first officer. He was flying the Airbus A321, which was in the Ockham stack south west of London on its way to Heathrow. Sitting behind was a check pilot who was monitoring his every move.

The Captain was handling the radio. He received instructions from the Heathrow intermediate director south at the London Terminal Control Centre, West Drayton, to descend to flight level 110 (11,000 feet). Although he read the clearance back correctly, the first officer entered FL100 into the flight management system.

Investigators were later to conclude that he'd been distracted by suggestions and advice being passed to him by the check pilot, who hadn't noticed the captain's failure to check the first officer's actions.

As a result, the aircraft came close enough to a second Heathrow-bound A321 to convince its pilot there was a medium to high risk of collision. His TCAS (traffic alert and collision avoidance system) warned him that the first Airbus was descending toward his aircraft. Meanwhile, the situation had also been noticed in the control room and the first aircraft was given fresh instructions by the controller.

A breakdown in crew resource management was blamed for the incident. The controller and the crew of the second Airbus were commended for their alertness in ensuring that the incident ended without risk of collision. It was, though, a classic level bust. In the UK such incidents are defined as a deviation of 300 feet or more from an assigned level. Although this implies controlled airspace it doesn't necessarily mean incidents don't happen in uncontrolled airspace.

It's also important to point out that only about 12 per cent of level busts result in loss of standard separation: 1000 feet vertically or three nautical miles laterally in the TMA, and five or 10 nm laterally in en-route airspace. This means that while separation has been lost, it may not necessarily have come to the attention of the pilot or noted by TCAS.

After consultation with airlines NATS doesn't recognise 'late re-clearances' as level busts. A controller may stop a climbing aircraft at, say, flight level 130 when it's passing FL 125 - too late to comply with the instruction - and the aircraft temporarily goes beyond the newly cleared level but not past the originally-assigned one. NATS considers this sort of event to be under the control of the controller who has changed the assigned level rather than a case of an aircraft failing to maintain it.

Level busts often involve only one aircraft. This is, of course, purely fortuitous but the risk remains the same. It's possible that only one in three incidents is actually reported and it's considered important that all incidents are so that lessons can be learned.

In 2003 the rate of incidents was about half that of the previous two years, and although 2004 shows an increase, the rate is still below that of 2001 and 2002. Analysis of causal factors shows that adherence to standard operating procedures (SOPs) and use of best practice could do much to reduce the number of incidents (see chart 1). In 2003, over 50 per cent of level busts occurred at or below FL100, about 45 per cent happened in the London TMA and 53 per cent were in the climb phase.

The danger was recognised by the Civil Aviation Authority (CAA) in the early 1990s and a working group comprising pilots, air traffic controllers, safety regulators, safety investigators, human factors experts and statistical analysts was established to study the problem.

Initially, the general consensus in Europe was that level busts were a UK issue. However, it may have been noticed here first because of the number of confliction points and routes separated by 1000-foot stop-offs, making a level bust more likely to result in a reportable incident. This is especially true of the London TMA with its complex airspace and large number of major airports.

Improved airline internal reporting systems as well as data from safety regulators indicates that it's actually a worldwide phenomenon. The international attitude towards level busts has therefore changed over the last few years. NATS has been working with Eurocontrol to provide statistics and expertise to reduce the risks. The agency has established a focus group and is creating – with NATS' assistance - a 'toolkit' to help airlines and controllers reduce the number of level busts.

Sleep, If You Can

By Dr David Stevenson, RAF Centre of Aviation Medicine

Growing older definitely has its advantages-for example, your adolescent children cease being adolescents. At 56 years of age, I have experienced this glorious event three times. However, nature never promised you a level playing field. The hard fact of life is that, as we mature, our nervous system changes in ways which will adversely affect our performance of flying duties. This article discusses changes in the way we sleep, and some of the effects that these changes can have. They can have a profound effect on our waking mental function. I am writing this because I think it is of value to be aware of which changes are likely to take place as you grow older, to be prepared for them, and consider how you compensate for their effects.

- Falling asleep during the day, when you do not want to, is abnormal. Falling asleep during meetings and lectures, in the absence of frank neurological disease, indicates inadequate night time sleep. From my readings and personal experience, most working people in the western world do not get enough night time sleep. The majority of people need 8-9 hours of sleep per night, not just time in bed. Those who need much less are exceptional.

- From the mid-twenties on, the actual quality of sleep diminishes. It becomes more difficult to fall asleep. Deep sleep, thought to be the most "restorative" part of sleep, lessens. By "later decades' there is almost no deep sleep.[1,2]

- Sleep is less satisfying. "Both total sleep time and the continuity of sleep decrease steadily with increasing age"[3]. We wake more often during the night independent of having to go to the toilet, which itself can occur more often. So, we tend to stay in bed longer and sleep less. As a result, we may fall asleep during the day.

- Our circadian sleep pattern tends to advance ('left shift") towards becoming sleepier earlier in the evening. which may result in early morning wakening even if we do not go to sleep at an earlier time . This lessens the total quantity of sleep (unless you go to bed earlier), contributing to daytime drowsiness and diminished alertness.

- Adolescents, by the way, are "right shifted' so that they prefer to stay up late and sleep late. They also need more sleep. They are not simply constitutionally lazy as I had thought. Earlier school opening is therefore a bad idea.

- Consequences of experiencing inadequate sleep:

  (a) Drowsiness, voluntary and involuntary naps during the day. This results in an increased incidence of 'micro-sleeps", scientific jargon for nodding off, and frank sleeping during fllght.[4]

  (b) Slowed response time.

  (c) Difficulty sustaining attention.

  (d) Diminished ability to integrate individual components of a situation together to form an integrated picture of what is happening at any moment.

  (e) Impaired memory and concentration.

  (f) Relationship problems, eg short temper, social withdrawal, contributing to poor crew resource management.

  (g) Increased risk of accidents.

- There are no medical problems associated with these shifts: they are simply socially inconvenient and may, through their effects on alertness and concentration, adversely affect flight safety.

- Most people who fall sleep during the day do not "suffer from insomnia', they simply don't get enough sleep. Insomnia is neither a disease nor a sleep disorder: it is merely a complaint-difficulty falling or remaining asleep. The vast majority of people with this complaint can do something to lessen the insomnia-see below.

- It goes without saying (but, I shall say it anyway) that quiet, dark, climate controlled sleeping environments enhance good sleep whatever one's age. In the military. these factors are considered luxuries. They are not - they directly affect the operational capabilities of fliers as well as maintenance and air traffic control people by influencing the quality and quantity of their sleep.

- There are, of course, medical conditions which may adversely affect the amount and quality of sleep, and which may require professional intervention. Among them are limb movement disorders, sleep apnoea (the main symptom of which is extreme snoring), narcolepsy, and the most common culprit, side effects of drugs including caffeine, nicotine, and/or alcohol. If you feel that you may have a medical condition interfering with sleep. you should discuss the matter with your SMO.

Medical conditions aside, we need to accept that obtaining adequate, good quality sleep will become more difficult as we reach our more mature years. It becomes necessary to take more care regarding our sleep habits in order to avoid the additive adverse effects which increased sleepiness, in combination with fatigue, an unfortunate and all too common fact of our busy professional lives, can have.

I find that more mature people often deal with fatigue better, in medicine for example, because they learn how to take it into account and compensate for fatigue induced deficits. For instance, we (older folk) appreciate the wisdom of not burning the candle at both ends, and refrain from late night social escapades if fatigue is an anticipated problem. This is a learned ability which we need to teach our younger colleagues. Awareness of the ways in which sleep changes with maturity leads to anticipating the changes, mitigating their effects, and flying more safely. Sleep well tonight.

"In the Military, these factors are considered luxuries"

I did not intend to lecture the reader with a long list of 'dos and don'ts', but I am advised that discussing a problem without suggesting remedies is not the best of practices. However if I look at my own behaviour, I have to admit that it is very difficult to follow much of this advice. In an ideal world, we should consider the following:

- Aerobic physical fitness enhances the ability to fall asleep and sleep well.[5] However, don't engage in vigorous exercise just before bed. I have never been able to ascertain how this advice applies to sex.

If all else fails - there's always counting sheep

- Regarding light exposure:

  (a) If you have difficulty falling asleep, don't expose yourself to bright light in the late evening.

  (b) If you want to stay awake late, it may help to expose yourself to bright light late in the day and in the evening,

  (c) If you have to go to the toilet, don't turn on the light (use a dim night-light if necessary).

- If you awake at night, don't turn on the light and don't look at your clock. This only awakens you more, and will have no effect whatever on the inevitable progression of time.

- Try to avoid emotionally charged activities just before sleep. At bedtime, don't argue with your spouse; don't watch the ten o'clock news; don't ask your teenager if they have done their homework.

- If you can't sleep, get out of bed and sit in a dimly lit room until you feel sleepy again. Don't simply lie in bed trying to go to sleep - the experts say that this in counter-productive.

- Drinking caffeine just before bed is not very smart, no matter what people do or say. It diminishes the quality and quantity of sleep. Don't take caffeine within four hours of retlring.[6]

- Ethyl alcohol can make it easier to fall asleep, but in the early morning hours a "rebound wakefulness" may occur, diminishing the overall quality and quantity of sleep.

- Continue your sleep/wake schedule through weekends and holidays. I wonder how many of those who recommend this practice actually do it themselves. If you accept that most people do not get enough sleep during the work week, there is something to be said for making up the sleep deficit during the weekends.

- Don't go to bed hungry - the books say that milk and bananas can promote sleep.

- Seek medical care if you suspect that medical factors are contributing to sleep difficulties, or if you simply do not understand why you are having difficulties.

It turns out that there is some skill involved in sleeping well. The reader should take what seems helpful from the above and use it; discard the rest. I am reminded that "those who can tell the difference between good and bad advice, don't need advice."

1 Caldwell, JA; Caldwell, JL; Fatigue in Aviation - A Guide to Staying Awake at the Stick. Ashgate Publishing Ltd Aldershot 2003, p.68

2 Dotto, L; Asleep inthe Fast Lane. Stoddart Publishing Co. Ltd. Toronto 1990; p.39

3 Ibid.; p.38

4 Caldwell, op cit, p. 100

5 Ibid., p.100

6 Ibid., p.101

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Thunderstorms – From the Top Down

by Paul Ferreira

There is no doubt that a thunderstorm is one of nature's greatest forces. It houses more power than four nuclear bombs. It generates an average of 100 lightning strikes per second and, at any one time on planet earth there are over 40 000 thunderstorms.

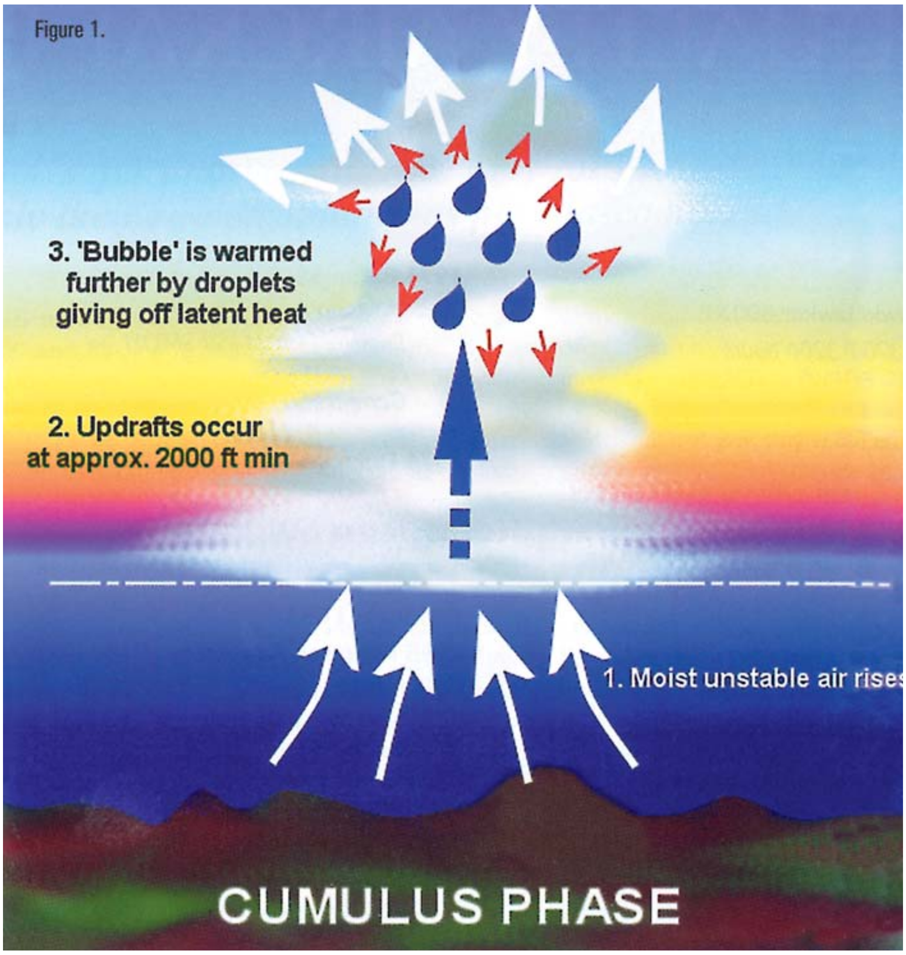
It houses monsters such as squall lines, tornadoes, hurricanes, mesoscale convective complexes, super-cells, microbursts, hail, severe Icing, turbulence, derechoes and the complex gravity wave.

To quote the USAF Weather Handbook: "WARNING: When you fly through a thunderstorm, the hazards that face you are extreme. You will be betting the aircraft, your life, and the lives of your crewmembers on the forces of nature. This must be the only remaining alternative!"

It is then beyond me, why anyone would consider getting close to a thunderstorm.

Before we look into the eyes of a thunderstorm, let us look first at the lore of thunder: NEVER, EVER fly into a thunderstorm! Now, we do defy gravity in Africa and we do have our fair share of storms. Summer is approaching and the skies will soon start to boil. So what does one do?

Arm yourself with as much knowledge as possible. What follows is a brief look at Mother Nature's monster, how it works and a couple of rules to apply when staying well clear of it.



Definition

It is very easily defined. A thunderstorm is a cloud of extensive vertical development in which thunder is heard – .actually from when the first thunder is heard until ten minutes after the last thunder is heard.

I often get students saying that it is from when lightning is seen, etc. If that were the case, it would be called a lightning storm. It is called a thunderstorm for a good reason.

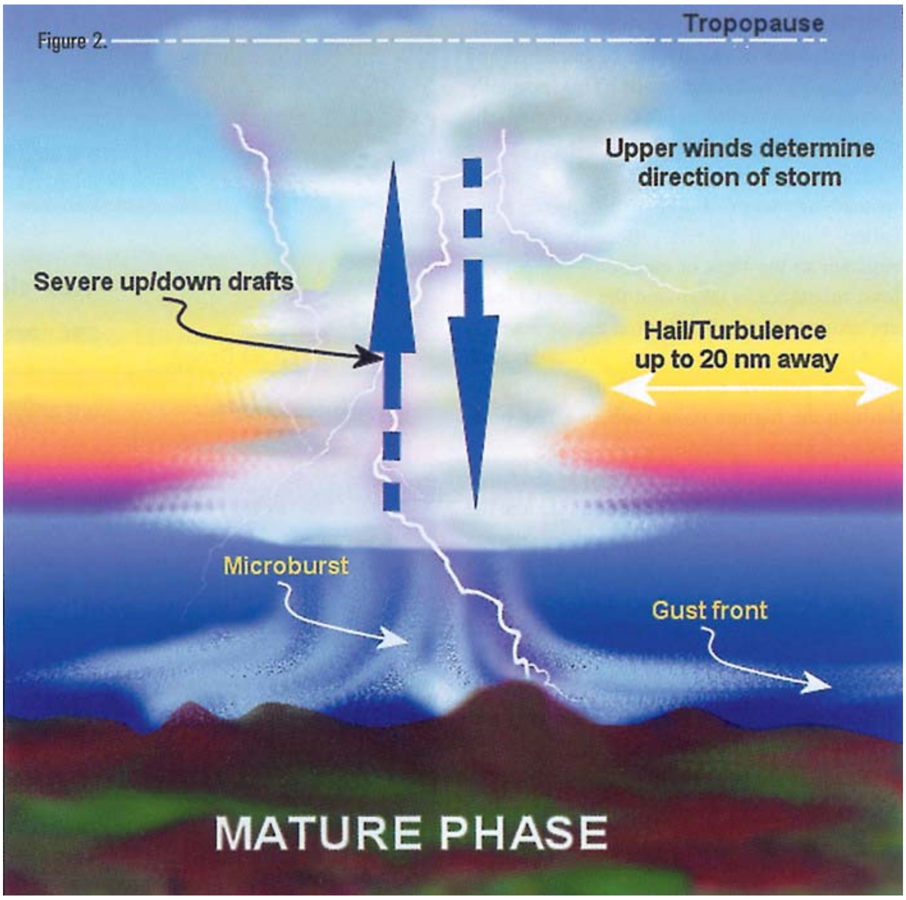
The requirements for the development of a thunderstorm are unstable air, moisture and a trigger or lifting action. The lifting action could be orographic (like the storms over the Drakensberg), frontal (any front – warm, occluded or cold – can have thunderstorms) or convergence (when two air masses collide – one must surrender and go up).

It is this lifting action that determines the name of the type of storm. The instability as well as the moisture content determines the severity of the storm. And without a doubt, a cold front, with its steep slope and it rapid lifting action, causes the most severe thunderstorm, usually in a squall line.

Stages

There are three stages to a thunderstorm: the cumulus, the mature and the dissipating stage. The whole process could last from 20 minutes to a few hours. The moisture content and instability of the air (the fuel of a thunderstorm) determines the severity and duration of the storm.

In the cumulus or developing stage, warm, moist, unstable air is forced to rise. This sets off a chain reaction that forms the storm (see Figure 1). Remember, the air is unstable because the "bubble" of air



is warmer than the surrounding air. In the cumulus stage updrafts of 3000 feet per minute have been recorded. This occurs from ground level to well above the storm.

In this stage, the cooling air releases energy in the form of latent heat. This expands the "bubble" of expanding, unstable air, which perpetuates the process even more. Water droplets form and as they are flung upwards, they collide with other droplets to form even bigger drops. Due to the energy released, the water droplets remain in a liquid state well below temperatures where they would normally freeze. These droplets become visible as towering cumulus clouds (TCu).

As the water droplets grow in size, they become heavier. There comes a point where the updrafts can no longer suspend these droplets. Precipitation begins and the water droplets fall to the earth dragging colder air behind them. This is called "entrainment". This entrainment causes downdrafts which mark the onset of the mature phase of the storm. These downdrafts can be in the region of 2500 feet per minute.

The entrainment causes drier air to be sucked into the storm from above, which, in turn, causes some of the water droplets to evaporate. The evaporation absorbs latent heat which makes the air even colder. The colder air now accelerates to the earth at an even higher speed. This cold air eventually strikes the ground and spreads out causing gust fronts, high speed winds and windsheer (see Figure 2).

When the surface downpour is concentrated in a radius of less than four kilometres it is called a microburst, and if it is on a large scale it is referred to as a macroburst. It is these microbursts that have a profound effect on piloting an aircraft safely as they are for the most part, undetectable. But that forms an article all on its own.

As the storm grows in intensity, growth rates of 8000 to 10 000 feet per minute can be expected. With the violent up and downdrafts located in such close proximity, a droplet could find itself falling earthbound, collecting more water, then find itself being thrown back up. This could eventually lead to the formation of hail.

This constant friction of the up and downdrafts as well as the friction between the water and the air molecules causes the storm to become electrically charged. The eventual discharge is seen as lightning and heard as thunder. Turbulence at this stage is severe and at its peak intensity, the storm reaches the Tropopause where the upper winds spread the ice crystals out in the all too familiar anvil shape.
Eventually, all the energy is used up by the storm and the updrafts cease. This is the onset of the dissipating stage. Downdrafts form all over the storm and they use up the remaining energy. All that remains is the floating anvil.

Dangers

Thunderstorms can last from 20 minutes to a few hours. They usually form in clusters. This is mainly due to the fact that the gust front, emanating from the front of the original storm, forces more air to rise and triggers yet another storm with a life of its own.

Figure 3

Where a lot of moisture is present, these clusters of storms form what is called a Mesoscale Convective Complex (MCC): a pile of thunderstorms clustered together like giant warts on a frog. Not a pleasant sight (see Figure 3).

Even worse, is when middle level winds cause the storm to tilt from the vertical. As altitude increases, so the wind speed increases. This sheer in wind causes a wave-like motion much like a roll cloud, or like waves on a beach (see Figure 4). Now, if this rolling air can tilt upwards and match the rolling of the tilted storm cloud, it could dramatically add to the intensity of the storm (I equate it to a cobra raising its head).

These storms rise to over 60 000 feet in height and they "punch" through the Tropopause. These storms are referred to as super-cells. If the rolling is intense enough, tornadoes form. These super-cells last for hours, travel for hundreds of kilometres and spell certain death for any pilot who dares challenge them.

If that is not bad enough already, Derechoes, meaning straight-line winds, can cause widespread damage. A Derecho occurs when a cluster of storms or MCC contains gust fronts that stretch over a fairly large distance. These fronts are usually in a straight line and they cause surface winds of up to 100 knots.

Lightning

In all of this chaos, the storm becomes electrically charged. It is this charge that causes lightning. There is a thin layer of negative charge at the top of the storm; the anvil has quite a strong positive charge; there is a large concentration of negative charge at the freezing layers of the storm; and the bottom of the storm is positively charged. Below the storm is a very strong area of positive charge (see Figure 5).

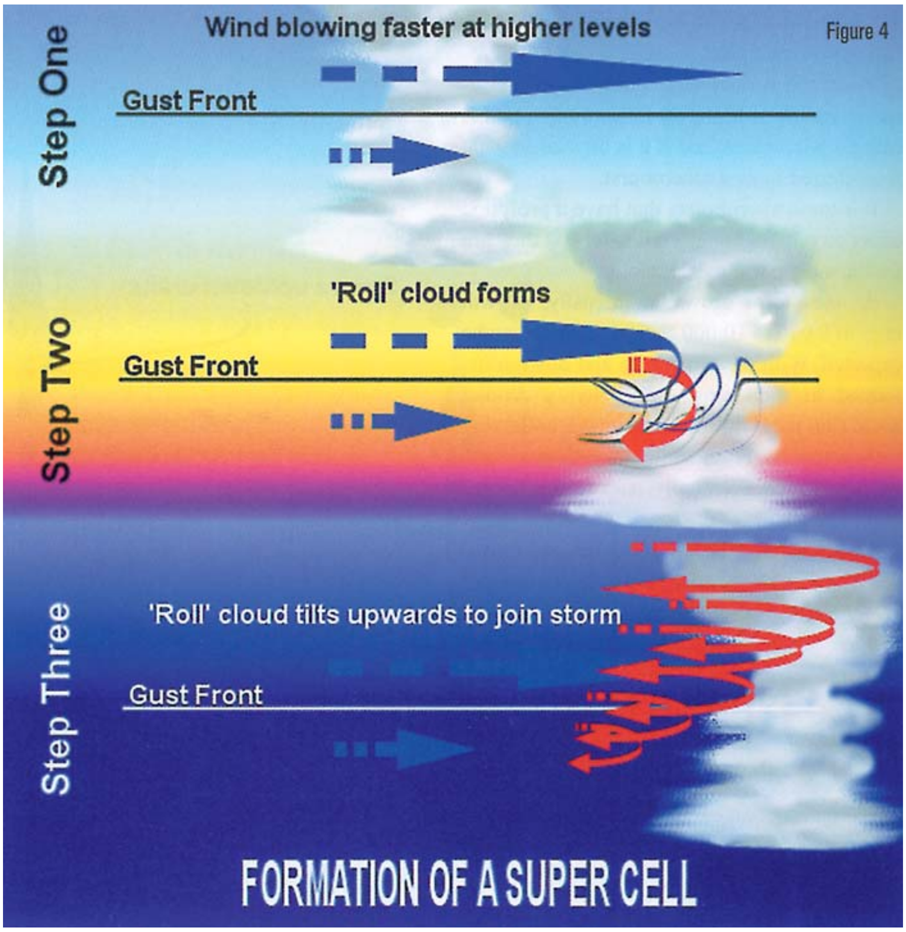
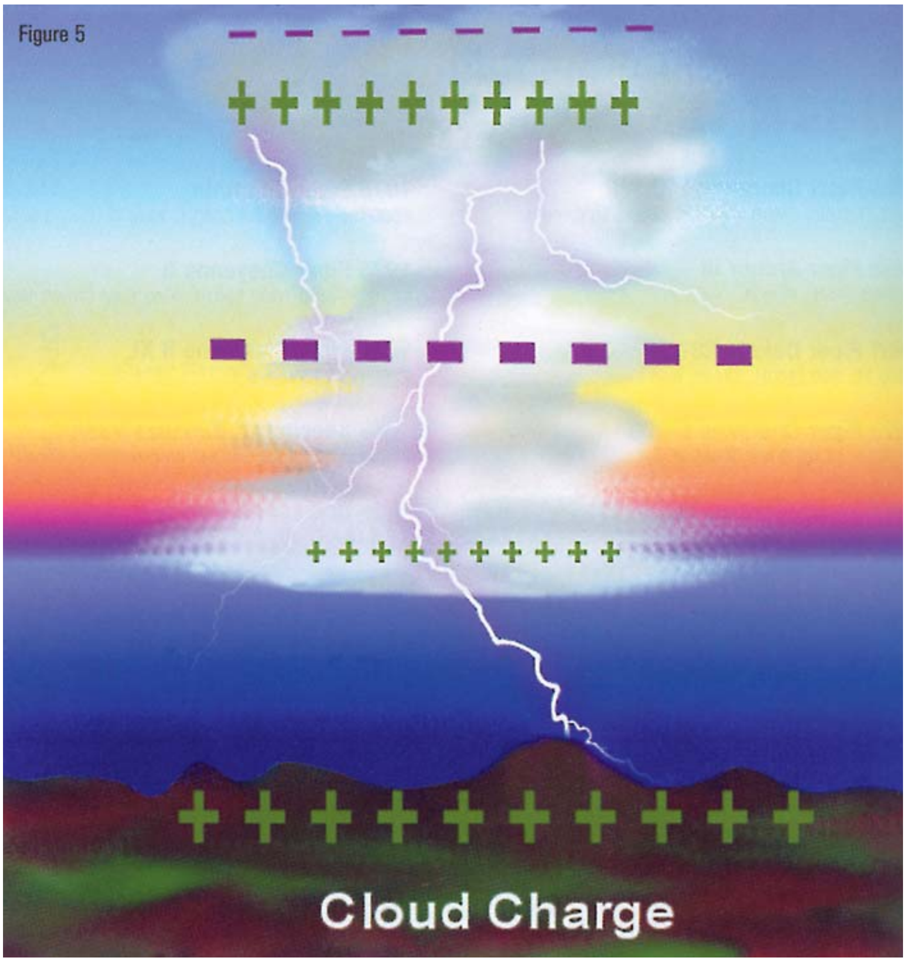


Figure 4



If the charge becomes high enough, the natural resistance of the air will be breached and a discharge will take place. This normally occurs within the storm but can occur from the positively charged ground.

The discharge does not occur all at once. Instead, it sort of leaps in 10 to 20 metre steps called "stepped leaders". Because air is so resistant to the flow of electrons, the path of least resistance is taken and the stepped leaders take on the familiar forked appearance. As the positive and negative near each other, a positive streamer finds its way up through the highest point such as a flag pole, tree or human.

When contact is made, a massive discharge occurs along the length of the streamer and the collision of positive and negative charges causes the molecules to heat up to 10 000 degrees Celsius – hotter than the surface of the sun! The air expands supersonically and we hear thunder. The familiar rolling sound is the sound of the different parts of the leader reaching our ears at different times.

Because the area in and around the discharge is super-heated, the resistance is also reduced. This allows more charge to flow readily and within a split second, more discharges take place. This gives rise to the appearance that the lightning is flickering.

Hail

Hail competes with turbulence as the greatest thunderstorm hazard to aircraft. Super-cooled drops above the freezing level begin to freeze. Once a drop has frozen, other drops latch on and freeze to it, so the hailstone grows – sometimes into a huge ice ball.

Large hail occurs with severe thunderstorms with strong updrafts that have built to great heights. Eventually, the hailstones fall, possibly some distance from the storm core. Hail may be encountered in clear air several miles from dark thunderstorm clouds.

As hailstones fall through air whose temperature is above 0 ˚C, they begin to melt and precipitation may reach the ground as either hail or rain. Rain at the surface does not mean the absence of hail aloft. You should anticipate possible hail with any thunderstorm, especially beneath the anvil of a large cumulonimbus. Hailstones larger than 12 mm in diameter can significantly damage an aircraft in a few seconds.

Turbulence

Potentially hazardous turbulence is present in all thunderstorms, and a severe thunderstorm can destroy an aircraft.

The strongest turbulence within the cloud occurs with sheer between updrafts and downdrafts. Outside the cloud, sheer turbulence has been encountered several thousand feet above and 20 miles laterally from a severe storm. A low level turbulent area is the sheer zone associated with the gust front.

Often, a “roll cloud” on the leading edge of a storm marks the top of the eddies in this sheer and it signifies an extremely turbulent zone. Gust fronts often move far ahead (up to 15 miles) of associated precipitation. The gust front causes a rapid and sometimes drastic change in surface wind ahead of an approaching storm.

It is almost impossible to hold a constant altitude in a thunderstorm, and manoeuvring in an attempt to do so produces greatly increased stress on the aircraft. It is understandable that the speed of the aircraft determines the rate of turbulence encounters.

Stresses are least if the aircraft is held in a constant attitude and allowed to “ride the waves.” To date, we have no sure way to pick “soft spots” in a thunderstorm.

Updrafts in a thunderstorm support abundant liquid water with relatively large droplet sizes; and when carried above the freezing level, the water becomes super-cooled. When the temperature in the upward current cools to about -15 ˚C, much of the remaining water vapour exists as ice crystals; and above this level, at lower temperatures, the amount of super-cooled water decreases.

Super-cooled water freezes on impact with an aircraft. Clear icing can occur at any altitude above the freezing level; but at high levels, icing from smaller droplets may be rime or mixed rime and clear. The abundance of large, super-cooled water droplets makes clear icing very rapid between 0 ˚C and -15 ˚C and encounters can be frequent in a cluster of cells. Thunderstorm icing can be extremely hazardous.

Tornadoes form within super-cells. They have the highest recorded wind speeds on the planet and if you fly into one, you will die. So will the aircraft. Stay away!

Weather Radar

The use of proper weather radar techniques is paramount in thunderstorm avoidance. This topic will be covered as a separate article due to its enormity.

Summary

A summary on thunderstorms is simple. Stay away from them at all times! Keep in mind the power they exert and remember that they form at a phenomenal rate. The dangers that lurk inside mean that it is just not worth it. As always, please feel free to send me your comments or criticisms to paul@logwiz.co.za or log on to http://www.avcom.co.za to have your say.

In the meantime, here are a few does and don’ts…

- Don’t try to fly over thunderstorms. There are hidden dangers above the storm. The rule of thumb is 1000 feet for every 10 knots of wind. That makes it beyond the performance of any modern passenger plane. They also can grow rapidly through your altitude, producing severe turbulence.
- Don’t try to fly under a storm, where hail, lightning and turbulence can occur.
- Don’t fly under the anvil where hail damage and lightning can occur.
- Avoid all thunderstorms by 20 nm or more since lightning, turbulence and hail have been known to extend that far from the clouds.

Also, do not attempt to fly between two cells closer than 80 nm apart.

…and Do’s

- If you do enter a storm, inadvertently, go straight. Don’t turn around.
- Avoid the altitudes with temperatures of plus/minus eight degrees Celsius.
- Don’t chase altitude. Hold your attitude and watch airspeed.
- Use all anti-icing equipment.
- Turn all lights in the cockpit on full brightness to minimize the chance of being blinded by lightning.
- Lock shoulder harnesses. Secure the cockpit.

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