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focus

ON COMMERCIAL AVIATION SAFETY

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Contents

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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: Monarch Airbus A321

UK Flight Safety Comittee and the European Aviation Safety Agency

by Peter G Richards FRAeS Non-Executive Board Member

The European-wide environment for Aviation Safety is held within the European Aviation Safety Agency. This body, although legally empowered to manage, has yet to include a Flight Safety Committee equivalent to that which we possess in the UK. But things are moving in this direction quite quickly, with the recent formation of the European Commercial Aviation Safety Team or ECAST. The ECAST is part of the three pronged approach to The European Strategic Safety Initiative, ESSI. The other two parts are the European Helicopter Safety Team and the European General Aviation Safety Team. The UK already has close engagement with the EHAST helicopter team, through the engagement with them by the UK Military Aviation Regulation and Safety Group – MARSG.

The emphasis within ESSI is to focus on Incident Analysis and this is something that we in the UK are pretty good at. Merely collecting data and copying it to the reception centre, based in Italy, is not going to advance safety one iota. Using 'tools', like the plenary UKFSC meetings and networking opportunities, certainly helps to fulfil this need. Above all else, there is a need to avoid duplication of effort, in the analysis and mitigation strategies.

In my last editorial I wrote 'Closer co-operation with other flight safety organisations and better engagement with regulators and government bodies…' as desirable objectives that the UKFSC should aspire towards. Towards which – a marriage or a take-over?

A recent UKFSC meeting made a significant step further in this direction, with the invitation from John Vincent, the Head of EASA Safety and Research, speaking at length at the meeting, that the Committee should consider joining the ECAST. You will find some more details from John, about the work of ECAST, elsewhere in this issue.

If the engagement with ECAST is to prove synergistic with UKFSC aims and objectives, then the participating ECAST membership will need to become much closer in ideology to the UK model. We know that our model works well here in the UK, most of the time. Can the 27 EASA Member States, plus Iceland, Liechtenstein, Norway and Switzerland accept that our capabilities and conditions will be acceptable for them?

We have strong competence and commitment drivers within our organisations associated with aviation safety; both civil and military, commercial and general. 2007 was a 'good year' in commercial safety terms, but a 'poor year' for general/sport/leisure flying. We cannot fall back on our laurels, with 2008 commencing with a major hull loss at Heathrow, fortunately with no loss of life and few injuries. Yet all the focus we have here in the UK is directed towards problem solving rather than blame allocation and this is where my earlier question will be answered.

Marriage or Take-Over? It will be a function of the UKFSC at their AGM to make the first step. Which way would you propose? My vote from the Royal Aeronautical Society Flight Operations Group will be that a 'marriage' is preferred. Working within something to change and improve it is far better than sniping away from the world outside.

This year we celebrate 100 years of fixed wing aviation here in the UK, where we can justifiably claim that enthusiastic support for the project took root. There will be a full season of air displays and, should we enjoy a better summer than in 2007, there will no doubt be many 'general aviation' flights to and from these events. So I take this opportunity to remind those readers who enjoy such activities to pay particular attention to the Restricted Areas (Temporary) – RA(T)s instructions and the R/T communication standards required to inter-act in and around such areas.

This will be my last editorial, for, as I wrote in the last edition, the new UKFSC CEO is appointed and his details are on the home page of our website www.ukfsc.co.uk

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.**

focus ON COMMERCIAL AVIATION SAFETY

Safety Information Exchange (SIE)

by Robin Berry, CTC Aviation Services Ltd

Exchange of safety information has been the bedrock of safety management for as long as man has inhabited this Earth. The basic premise of "Look what happened to me and don't let it happen to you!" has been around since Adam and Eve's big mistake. It became an integral part of Flight Safety the day Icarus flew too close to the sun – an early warning to stick to SOPs!

Throughout the history of aviation we have strived to learn from our mistakes and the mistakes of others to bring flying to its current enviable level of being "a safe way to travel". Of course, in the early days, there were plenty of "mistakes" to learn from. But there was also the somewhat flawed assumption that an accident had to happen before we could learn.

In more recent times things have got much better. Modern Safety Management offers the opportunity to consider what might happen so that we can take steps to minimise the likelihood of it ever actually happening. "Near Miss" theory encourages us to look further than accidents and consider the lesser incidents that might, in other circumstances, have become an accident (although "Fatal Accidents" still seems to be the bottom line of safety statistics). The "Accident Chain" theorists urge us to consider all of the possible contributory "links" that could lead to an accident and take steps to reduce the risk from them all. This leads on to the "Organisational Accident" concept promoted by James Reason and others – we mustn't just look at the front end of an operation, our Safety Management System must consider every part of the organisation and the part it can play in reducing risk.

All of these theories rely on us knowing what the risks are and here we come back to Safety Information Exchange. No amount of sitting round a table brainstorming can come up with everything that could possibly go wrong. We need information – Has it happened before? To us? To someone else? Indeed, one of the best aids to Risk Assessment is information on past occurrences – not just the big accidents, but all the little links that made up the chain – because this is, in part, the answer to the right hand side of the "How Bad, How Often" equation of risk assessment.

Many systems have been developed to promote Safety Information Exchange either voluntarily or by decree. The UKFSC has its voluntary SIE as an integral part of its meetings, the UK CAA developed its Mandatory Occurrence Reporting system, IATA has its STEADES system and there are many others. But all of these systems have one common weakness – they are only as good as the information they receive!

Mandatory systems probably have the most consistent data because the type of information required is set out in the mandate. There are no ways of avoiding reporting, if it fits in the frame it must be reported by law of the land. But this is only a subset of the total data available, usually limited to the more serious events.

Voluntary systems give the opportunity to include a much wider spectrum of data, but, because they are voluntary, are more open to "commercial" pressure not to partake. All CEOs are wary of their domains being cast in a bad light commercially as a result of the dissemination of safety details about its operations. Yes, they are happy to send their Safety Manager along to meetings to hear of others' bad days but aren't so keen to share their own learning points! Of course, the much lauded "Chatham House Rules" under which most organisations conduct their SIE sessions provides some protection, but how effective is that? It only takes one misinformed article in the popular press to cause the most open and honest reporter in the realm to clam up.

The foregoing then begs the question "What do we do with the exchanged information within our own organisations?"

Timely and effective dissemination of safety information is still one of the most effective weapons in the safety armoury. Forewarned is forearmed! But how timely and effective is your system? Does the information merely languish in the file called "Minutes" or does it find its way into your organisation's training – and not just pilot training, but training throughout the organisation and its agents? How do you keep the message alive as the organisation grows and personnel change? Do we really learn from the information?

Two incidents may serve to make my point that SIE must be timely and effective:

1. Aircraft Trimming Incidents Back in the mid-nineties I was involved in the investigation of an incident in which a single-aisle 180 seat passenger jet tipped onto its tail when take-off power was applied. The incident occurred due to mis-handling of the loading process for the second leg of a split load charter flight from a Mediterranean island to two UK destinations. The UK AAIB investigated and issued a report soon after the event.

Some six years later I found myself asking "Why have AAIB re-issued this report?" I was actually reading a new report from AAIB on another incident – but the details were uncannily identical, right down to the Mediterranean island departure point, UK destinations and aircraft type!

So how effectively was the original AAIB report used within the second organisation? How long do details of incidents remain "relevant"?

2. CFIT Incidents during Non-Precision Approaches During my time with my last employer I investigated two serious incidents involving near-CFIT during non-precision approaches, one in 2003 and one in 2005. Both were passed to the UK AAIB for formal investigation at the time. At the time of writing this, AAIB have just published a Report on the later event but nothing at all has been published on the 2003 event. To be totally fair to AAIB, both incidents were investigated on behalf of the States of Occurrence and that has delayed publication. However, both of these events produced a number of learning points critical to Flight Safety in this data driven age. Surely interim bulletins could have been issued so that all could learn those points at the earliest opportunity?

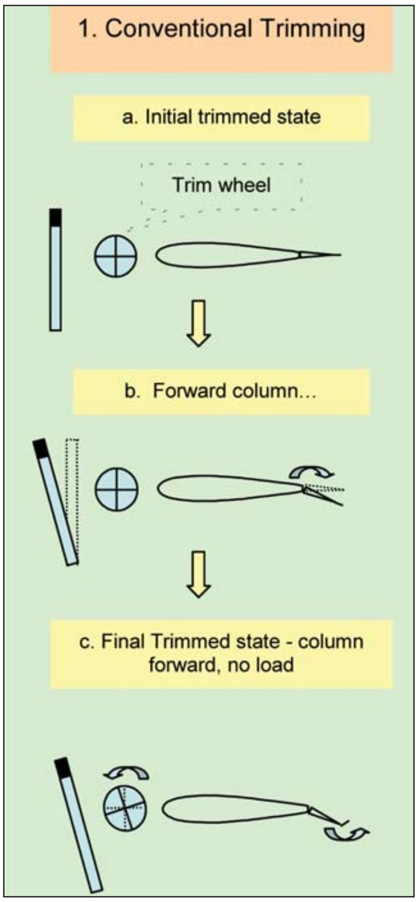
Perhaps, if timely publication had happened and effective use of the information had followed, I wouldn't have spent the other evening reading an "interim" report issued by the Australian ATSB on an incident nearly identical to the 2005 incident which occurred at Melbourne in November 2007?

**Details of the 2005 and 2007 incidents can be found in http://www.aaib.gov.uk/sites/aaib/publications/formal_reports/5_2007_g_medg.cfm and http://www.atsb.gov.au/publications/investigation_reports/2007/AAIR/pdf/aair200706727_prelim.PDF respectively.

Do you really understand how your trim works? Many do not, and why it matters

by Alex Fisher - GAPAN

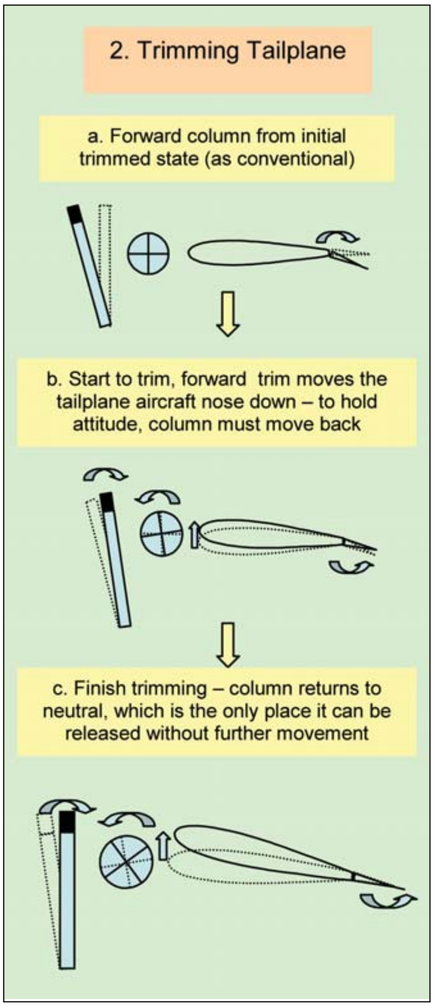
Picture yourself in a conventional airliner, say a 737 of any generation. You have to do a low level go-around, perhaps because your fail passive Cat III has just failed, er, passively. You apply GA thrust, and the aircraft pitches up. If you are low enough, you may already have some extra helpful nose up trim applied thanks to the 'design feature' that ensures that in the event of AP failure at low level, the aircraft pitches up not down, and so a few units of nose up trim are applied late in the approach. Your speed is low, about V_{app} and the thing is pitching firmly upward. You need ample forward stick/elevator to restrain it. You don't want to carry this load for long so you retrim. Question: if you run the trim forward while maintaining forward pressure on the wheel, what happens? Hands up all those who think the load reduces to zero. I see a lot of hands. My unscientific polling to date suggests that just about everyone is convinced that this is what happens, but it doesn't.



Nearly everyone of my generation trained on a Cessna 150 or a Piper PA28. You fly those aircraft by putting the attitude where you want it, holding it there by holding the stick rigid and retrimming until the load goes to zero. In fact if you didn't do that, but were too quick and started trimming before the aircraft was stable, the instructor would exhibit a severe sense of humour failure. Let's just consider what is going on. Starting from an 'in-trim' state, fig 1(a) (just for illustration I have shown it as everything in the middle, but obviously this isn't essential to the argument); then, fig 1(b), the column is held forward moving the elevator down. Moving the trim wheel, fig 1(c), in this case moves a trim tab which relieves the control load until it goes to zero; the column can again be released, and it stays forward where you left it. So in this scheme, the control column stays forward for high speed and back at low speed. Although I have shown a tab operated system, the same result can be achieved without a tab by means of a spring in the control circuit or by altering the neutral point of the feel system. Aircraft as diverse as the Tiger Moth, the L1011, and Concorde fly this way; even though the details of the control systems were very different (irreversible in some cases, definitely not in others), they all shared this characteristic that the trimmer simply relieves the load on the pitch control.

Now there is another class of aircraft that works totally differently. This group includes most conventional transports, and even the non conventional A320 series in direct law. In these, the tailplane is controlled directly by the trim system, while the control wheel controls only the angle of the elevator relative to the tailplane. Now starting again from the out of trim state we started from above (see fig 2), as the nose down trim is applied, the tailplane starts to move leading-edge up. In order to keep the force contributed by both the tailplane and elevator constant (i.e. to maintain attitude), the elevator angle has to be reduced as the tailplane incidence increases (fig 2b). To do this, the column/ wheel has to be moved back towards neutral. When the operation is complete, the column/ wheel is back in the neutral position, which is the only place it can be released without further movement (fig 2c); its position does not indicate the trim state of the aircraft. For years Boeing manuals have said flatly that the control wheel cannot be moved opposite to the direction of trimming motion (the trim motors cut out if it is)… Wrong, it can, and indeed has to, be moved in the opposite direction every time the trim is used; the action is achieved by just relaxing the pressure on the column and allowing to drift back to neutral. It is true that if pressure is applied to the column opposite to the direction of trim, then the trim cuts out.

This behaviour (column always returns to neutral regardless of speed) is not necessarily limited to aircraft with trimmable tailplanes; for example, if the column operates a servo tab while the trimmer moves a separate trim tab, the effect would be the same (I believe the 146/RJ series works this way). Doubtless there are other combinations too, you really have to study the systems carefully. Once again, aircraft



with very different control systems share one important feature, the pitch control returns to neutral when in trim.

When I converted from a 'conventional' trimming type (Trident) to a separate trimming tailplane (757), not a word on this subject appeared in the training notes, nor was anything ever said by any training captain. Many years later I did write something for the company Magazine and generic training manual, but apart from one reprint in the Far East it has not been widely circulated. So how do people go through an entire career without realising things have changed from the way they were first taught? I think it is because mostly any column movement is followed immediately by small movements of the trimmer, so large loads are never allowed to develop and the reverse column movements are virtually imperceptible. In 'normal' flight operations, movements in pitch are mostly quite small, apart from two: rotate and go around; the latter is relatively rare, while the former is transitory (if the take-off trim is roughly right (!) you can relax the load after lift off with the aircraft roughly at the right attitude).

So does it matter, and if so, why? The chances are you will fly more smoothly if you understand what is going on, but there are three broad categories of error which are likely if these subtleties are not understood:

1. Failure to understand the trim function (the process described above) itself. This usually isn't disastrous. Most pilots are in this category, but they cope well anyway, by simply flying on the trim. This isn't how they were taught, but, well, it works. It begins to matter when the trim changes are large. I have watched, in the simulator, a 737 go-around from a Cat III fail passive approach with its marked pitch up (as described above); HP kept his arms locked forward to contain the attitude whilst simultaneously running the trim forward with the thumb switch. I am sure he was expecting the trim to reduce push needed and he either didn't know, or had forgotten, that it wouldn't. We duly pitched straight back into the 'ground' as the tailplane incidence 'bit'. I can't cite with certainty any accident that has been caused by doing this, but I strongly suspect this was a factor in the infamous Icelandair upset event at Oslo[1] The aircraft went quickly from +20 deg to -40 deg and was only saved from a CFIT by a 3.5g pull up, bottoming out at 360ft. Sadly, the report does not discuss the control inputs, nor does it contain any FDR traces, so this trim confusion explanation must remain speculation. I would be astonished, however, if there weren't more examples of this error, particularly in unfamiliar situations.

2. Failure to realise that the tailplane, commanded by the trim system, is a totally independent pitch control; it will be available if the primary control is inoperative or ineffective. But if you only think of the trimmer, wrongly, as a column-load reduction device, you may not think of its other use when needed. The following examples illustrate the point; I am certain of the first, the others must remain speculation in the absence of evidence.

(a) 747-400 Take-off incident[2]. Just after lift off the aircraft suffered an elevator hardover, uncommanded full nose down movement of one elevator; the pitch attitude began to reduce. The crew's reaction not unreasonably was first to pull harder, then a lot harder, which succeeded in preventing an immediate accident, but cannot be said to have truly regained control. The anomaly lasted about 8 secs until a spike in the hydraulic pressure during the gear raising sequence allowed normal control to be resumed. No one thought of just blipping the trim button to restore order. Did thinking of the trim as merely a load reducer blind them to the simple solution? The incident report does not mention the alternative control available and does not discuss that part of the pitch control system at all.

(b) THY DC-10 crash at Ermenonville in 1974[3]. This was caused by an improperly secured cargo door which blew off; the floor above it collapsed due to the pressurisation load, disrupting the controls and injecting a nose down elevator input. Rumour, I admit quite unsubstantiated, has it that it could have been flown on the trim as there was still hydraulic power to the tailplane (350 casualties).

(c) The BAC 1-11 flight test super-stall[4]. There was insufficient elevator to recover, but the FDR trace shows that no attempt was made to adjust the tailplane which would have been more powerful. The incidence reached was so high that it is more than likely that nothing could have saved the aircraft, but it is intriguing that moving the tailplane wasn't tried, though many other avenues were; is it possible the crew thought of the trim as merely load relief? There would certainly have been no similar possibility for the Trident[5] that was lost during a pre delivery test flight in another super-stall accident a year or so later as the trim and column both operated the tailplane and its geared elevator together (see fig 3).

3. Failure to appreciate that loss of control in pitch might be due to the independent operation of the trim system. Several well known pitch upsets to A300s and A310s (see for instance the TAROM upset at Orly Sep 1994[6], and the A300 at Nagoya, April 1994) have been caused by a tailplane movement which was not fully appreciated by the crew, and was all the more insidious precisely because there was NO change to the load on the column. This is the reverse of the situation in (2) above. None of these occurrences were technically trim runaways, so there were no warnings and no indication to the crew from the feel of the column. The first incident started with the flap

3. Some all moving tailplanes are trimmed conventionally – the Trident's was commanded by both the column and the trim wheel; the 'elevator' was a geared tab (reproduced with permission from CAA)

4. Trimming tailplanes aren't confined to the jets – this Piper Cub has one, as shown by the slot near the tailplane leading edge. which provides access to the actuating link

overspeed protection system (the designers obviously thought that putting in nose up trim would reduce the speed... well it will if you understand totally what is happening and don't override it); the second, a fatal accident, started with an inadvertent, and probably unnoticed, GA selection.

A system where there are two independent means of control, has obvious safety benefits, but it also has pitfalls if it is not fully understood. The lack of importance given to the trim system in training seems extraordinary. I recall asking for TC guidance during my 757 conversion, to be told that there was no difference to previous types; when I finally convinced His Eminence that there was, he blustered that it didn't matter. I can find no relevant discussion in my (3rd)edition of the Bible, Handling the Big Jets; I guess the Test Pilots just cope with anything they come across without preconception, and perhaps don't realise how much baggage the rest of us carry from our basic training. Accident investigators would also do well to ask themselves more often just how the unfortunate pilots had been trained, and cover the likely rationale for the control inputs in their reports. The illustrations I have used are obviously very rare events, so it is very unlikely that any one reading this will ever face their like. Engine cuts at V1 are pretty rare too, but they get a lot more exposure in training than the basic control functions, odd, isn't it.

Safe flying

[1] www.rnf.is/media/skyrslur/2002/Flugatvik_TF-FIO_vid_Gardermoenflugvoll_22._januar_2002._(Endurutgafa).pdf
[2] http://www.aaib.dft.gov.uk/sites/aaib/publications/formal_reports/1_1995_g_bnly.cfm
[3] http://www.bea-fr.org/docspa/1974/tc-v740303/pdf/tc-v740303.pdf
[4] Brian Trubshaw: Test Pilot
[5] G-ARPY Felstead, 3 June 1966
[6] http://www.bea-fr.org/docspa/1994/yr-a940924/pdf/yr-a940924.pdf

What's The Rush?

by Captain Tony Wride

Many years ago, when I was learning to fly the B757, a wise Training Captain gave me some very good advice. "When something happens, before you start waving your hands around the cockpit sit on them for while and think carefully about what you are going to do, then do it slowly and methodically!" He was commenting on my inherited desire, drummed into me from my military flying, to react instantly to a problem and be 'punchy'. Whilst such lightening reactions may be required to save your life in a battle, in the commercial flying environment there are very few cases where such quick reactions are required. In fact rushing is quite often the last thing you should do and as many a Training Captain will tell you causes more people to ** things up in the simulator than anything else.**

Hold on! I am not advocating that we all become tortoise like in our approach to aviation just be very selective as to when you switch to hare mode! Let's see if I can persuade you.

Statistically the majority of accidents and incidents in commercial aviation happen during the approach phase, as has been demonstrated recently on the runway at Heathrow. A lot of emphasis has been put on "rushed" approaches and the need to steer people away from them. The introduction of Flight Data Monitoring has proved very effective at identifying rushed approaches **(see picture 1)** and, thanks to your efforts, the number of 'rushed' approaches in has decreased dramatically. You only have to look at the Gulf Air A320 crash to see what can happen when an approach is rushed and things start getting out of sequence. It is easy for me to comment in hindsight on this accident but anybody who looked at this particular crash will tell you that several miles away from the airfield it was obvious that aircraft had too much energy.

OK lets get physical! I'm no physics wizard but in simple terms an aircraft at a particular height has both kinetic (due to its speed) and potential energy (due to its height). These two energies combine to give "total energy". If we were to plot a graph of Total Energy against Distance **(see picture 2)** for an aircraft making an approach then in the ideal world there would be a gradual reduction in total energy as the distance decreased. Eventually at touchdown the only energy left would be due to the landing speed. For any given distance out there is an ideal Total Energy level. Our aircraft don't have total energy meters fitted but we do have altimeters and ASIs. Different aircraft types have different characteristics in a descent, the A330 in particular is a glider, and the manuals give guidance on the ideal profile in terms of distance, height, and speed. The particularly critical area is the bit after the target (you may prefer to call it a gate) on my graph. If the aircraft arrives at the 10 mile point at the ideal energy level (ideal height and speed) then the last 10 miles is a piece of cake, gales and thunderstorms can of course make it less palatable.

Where historically problems have occurred is if there is an excess of energy, as was the case in the Gulf Air crash. From the analysis of rushed approaches carried out they all share the same characteristic i.e. too much energy.

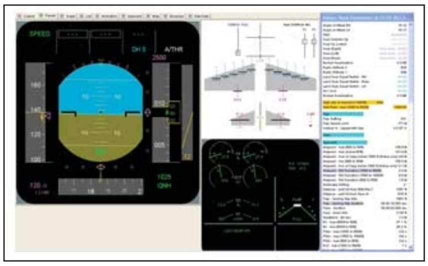
I have deliberately chosen the 10 mile point as a target since for a standard 3 degree glide slope approach this point equates to 3000ft AAL so if that target is right the potential part of the total energy is taken care of. This leaves the kinetic (speed) energy and it is often where we see the problem when analysing rushed approaches.

All too often we see flaps being selected very close to the VFE for that setting, which as has been highlighted by the aircraft manufacturers is not the ideal in terms of strain on the flap surfaces, and all the way down everything is happening late. It may be that by the 500ft point everything has just about stabilised out with the last bit of flap going out at 600ft but why make life so difficult! In my diagram I have drawn the green triangle to represent what might be considered the ideal area to be in to make "Tony's Target". You will notice that I am advocating (terrain permitting obviously) biasing towards having insufficient energy since it is often easier to add energy at lower levels than lose it. Before I get branded as a heretic, particularly in this era of high fuel prices, I am not advocating dragging the aircraft in with lots of power from a low level. This would not make either the commercial department or the environmentalists very happy!

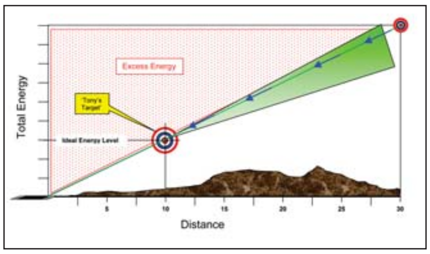
All I am suggesting is that at 30 miles out think about what sort of height and speed you want to be at to make my target. If you want a real challenge then the ideal profile, given ATC clearance, is to be able to follow my blue arrows to the target which means that at idle power your descent and deceleration (energy level) decrease at just the right rate. So maybe there is another target to aim for at 30 miles out, which will vary with aircraft type. Clearly being at 320 knots at 8000ft 20 miles out will put you well inside the excess energy area. Being at the same point at 250 knots moves you closer to the ideal and gives you more options to lose the energy i.e. you are closer to the gear down speed.

So what exactly is my point? Well my real target is to stop rushed approaches completely or if nothing else make sure that if any of us end up not making that final 500ft gate that we go around and try again. Don't rush. It's not worth it!

Picture 1. *An example of the quality of current FDM software.*



Picture 2. *Tony's Target!*



Level Busts – Learning the Hard Way

by Pete Riley, NATS

My own scary level bust moment came back in 1994 when I was a military supervisor at a large transport/refuelling base in central England (narrows it down a bit), operating temporarily in the Military Area Services Ops Room (MASOR) at the then LATCC (Mil) at West Drayton. The ops room at the aerodrome was being refurbished so it had been agreed to provide ATC services using the Area facility.

Turning and burning... still, we were all professionals...

On one particular Friday, during this arrangement, I was supervising while another detached controller was working providing an Approach Radar service to a VC10 (clue there) inbound to base from the North West. The controller had been pretty busy firing out instructions, but was 'turning and burning' and, in my opinion was coping admirably with the pace of the RT, to which he himself was contributing. Still, we were all professionals - and now things had quietened down a bit, he only had one aircraft to talk to. Who said supervising was difficult!

The controller had initially cleared the aircraft down to FL50 (Radar Advisory Service) and the aircraft was established in the descent with about 40nms to run to the Brize (oops – give away) overhead, when the Lyneham landline rang. I took the call on what turned out to be an outbound C130 on a North Easterly track towards the Daventry Radar Corridor requesting FL100. It also turned out to be a late prenote that became a handover, and the traffic was a 'dead ringer' crossing confliction on the Brize inbound. The controller seeing the developing situation took the line and agreed with Lyneham to get the C130 to stop its climb at FL60. He then instructed the VC10 to stop descent at FL70 and, he believed, heard the readback for this.

All sorted then... or so we both thought.

...Imagine our surprise, therefore...

Imagine our surprise, therefore when the VC10, despite having additional traffic information passed to it on the crossing track now at FL60, continued its descent through FL70. The controller, somewhat understandably confused by the continued descent of the VC10, queried the pilot on his apparent excursion from the stop off level. The pilot advised that he was on his way down to FL50 as briefed and then, rather unhelpfully, offered to stop at FL60. In hindsight the requirement was for immediate avoiding action and a discussion of this nature later. As it happened it was by now all getting too late and, providentially, the aircraft missed each other, although not without the pilots seeing each other through cloud... (that's not a gap in the cloud)...

Now I reckon that left only one thin piece of Swiss Cheese (big sky theory) between us, some grieving relatives, a lifetime of guilt and a guaranteed courtroom appearance. So how had we come so perilously close to a disaster that would undoubtedly have been one of the worst mid air collisions in the country's history??

The readback that the controller thought he had got turned out to be the other aircraft acknowledgement heard on the (still open) landline with Lyneham. The controller was expecting to hear a readback from the VC10 and missed the fact that the communication he did in fact hear was from a different source. This phenomenon is described, by people who know about these sorts of things, as expectation bias.

Safety nets? There was no TCAS fitted to the aircraft in 1994 and no Short Term Conflict Alert (STCA) on the transponder codes we were using for the Brize task – which had not been 'adapted in' to the LATCC system for this purpose. (Not that STCA would have helped much anyway in these circumstances as the conflict was only appreciated as separation was lost). It turned out the crew, who were very busy, never heard the stop descent instruction and didn't query their clearance apparently through an occupied level. That said, the (very experienced) VC10 pilot subsequently took a much greater interest in matters ATC, describing the event as the closest he had come to a near death experience during his lengthy flying career (which we had nearly ended).

...some choice personal observations...

Thirteen years later I still recall vividly the detail of the callsigns and indeed the time of the event (1021hrs) as if it were yesterday. I also recall that the Air Officer Commanding subsequently had some choice personal observations on the controlling team's performance on that day, one of which was that the supervision had allowed the controller and the RT to become too busy. This left a lasting impression on the rest of my controlling and supervisory career in the military and subsequently as a safety manager within NATS.

However, more recently I have also been blessed with the opportunity to partially atone for earlier misdemeanours through my involvement as the Level Bust Workstream Lead within NATS.

...and what have I learned as a result?

...the spy in the sky...

Firstly, that the two biggest causes of level busts remain the guy in the left seat and the guy in the right seat! Truth be told, very often in a level bust (about 33% according to the NATS causal factor scheme) the pilot says he will do something - then (for whatever reason) does something else. In London Terminal Control, now at Swanwick, and most recently at Manchester Centre, NATS has the ability to display the pilot's selected flight level from the MCP as a down-linked Mode S parameter on the controller's radar display. Think of it as the spy in the sky...So if you dial up something on the MCP other than the level you have been cleared to, the controller has an opportunity to spot the level bust before it happens – and you may be challenged. This safeguard has proven very effective and is also to be introduced into the new Prestwick Centre when it goes operational, planned for 2010.

However, we are still trying to understand what exactly goes on in the cockpit to cause level bust events which are described in an accurate (if not exactly catchy) Human Factors description as 'correct pilot readback followed by incorrect action'. To that end NATS intends to introduce a post incident questionnaire in Spring 08, which may help provide some of the answers. Our intention is for it to be not too onerous in terms of completion. (And should you be unlucky enough to have a level bust, we would of course be grateful for your support in the completion of this questionnaire).

...Level busts happen a lot... 1454 prevented level busts in a 10 day period...

I have also learned that level busts happen a lot. The NATS database currently records over 400 level busts reports in the rolling 12 month period. Fortunately, most of the time no loss of separation results. However, about 10% of the time it does and about 6 times a year (in the airspace in which NATS is providing a service) we still end up relying on the pilot and his/her TCAS resolving a level bust event which has not been detected in a timely or effective manner by ATC.

In 2006 NATS conducted a 'Prevented Level Bust Trial' which recorded (through use of a scratchpad on the controller workstations) some 1454 level busts or potential level busts in a 10 day period that were prevented by the intercession of the controller. Many of these involved the aircraft not stating its cleared level on first contact. A significant number of them involved confusion of the digits 2 and 3. So flights cleared, for example, to FL330 understood FL230 etc. Maybe it is time to go back to basics and use the correct ICAO pronunciation of the number 3 as 'TREE' – at least for levels or altitudes. In France they have addressed RT confusion with the French number one (un) by inventing a new word (Unité). Given that we use 2s and 3s for most of our cruising FLs and our VHF frequencies, perhaps we should do something similar. Certainly the change requiring FL100 to be described as FL 'one hundred' appears to have reaped some benefit as instances of FL110 / FL100 confusion are now much less frequent. A number of best practices phraseology techniques have been included in a Defensive Controlling Guide recently made available to all NATS controllers. These include tips such as avoiding 'expect' levels, stating the word 'degrees' after headings (to prevent level/ heading confusion) and not using the word 'maintain' (which can be misinterpreted by some crews as an instruction to climb or descend to a level). It also says that controllers should avoid using more than 2 executive instructions in one transmission and should not transfer an aircraft with a level instruction attached to the transmission.

...a clear question or 'say again'... would be more helpful...

Surprisingly often, (in the subsequent incident investigation) there is a clue on the RT that something is amiss with a level clearance. Sometimes the pilot will offer his/her own interpretation of the level cleared to in a somewhat questioning tone in the readback. Unfortunately this sort of subtlety is often missed by the controller (who may be busy thinking about the next instruction). We are now training controllers to adopt the WAYSRAYL technique, whereby they should Write (on the strip) As You Speak and Read As You Listen. However, if in doubt a clear question or 'say again' – rather than an inaccurate guess - from the pilot would be more helpful under such circumstances.

Step climb SIDs... far too often crews still manage to 'fall up the stairs'...

Standard Instrument Departures that include a stepped climb are a particular issue for level busts. On these profiles the first stop altitude is often the one which is bust. Whilst there is recognition that, as an airspace design principle, step climb SIDs should be eliminated wherever possible – because of the congestion in the London TMA we are likely to be stuck with them for some time yet. The trick, therefore, is to manage them. This includes displaying the steps in the profile properly on the charts used by aircrew, and the pilots briefing them appropriately before flight. Recently the joint CAA / NATS chaired UK Level Bust Working Group has liaised with a major chart provider to enhance the way first stop altitudes are displayed on its charts; however, far too often crews still manage to 'fall up the stairs'. NATS' statistics show this to be particularly true of business aviation aircraft which have additional pressures on their operation and who tend to use the airfields where step climb SIDs are common.

Altimetry is another big level bust issue. The relatively low Transition Altitude (TA) in the UK still appears to come as something of a surprise, and not exclusively to our American cousins. There is airspace policy, which should be fully realised in the next few years, to have a common TA inside CAS of 6000ft and 3000ft outside CAS. Most of the UK SIDs inside CAS end at 6000ft. However, some do not. At Birmingham, until the new TA is introduced, aircraft still fall foul of SIDs which end in a Flight Level. When pressures are low this can lead to a level bust when aircraft fail to set the Standard in sufficient time. Warnings (verbally and via NOTAM) have been introduced to alert crews to the danger in these circumstances. Of course it only takes 10Mbs for the confusion to result in a 300ft deviation from the assigned altitude or level – and therefore a level bust. We have a suspicion that altimetry events are more common than the statistics suggest and that there may be many more deviations which don't result in the 300ft discrepancy. Since 2005 NATS has been sharing its data with its customers through the Safety Partnership Agreement. A league table of level bust performance, normalised per 100 000 movements, is maintained and data on 50 individual operators sent out to the carriers' flight safety departments. Some airlines are now using this information as a key performance indicator. The data is useful to us in identifying emerging trends and as a subject for continued dialogue with the airlines.

...It still troubles me...

Since my own level bust experience 13 years ago, I think I now understand level busts and their causes a great deal better than I did back then. I hope that this article has helped raise your awareness on some of the issues.

However, it still troubles me that some of the things that went wrong on that Friday remain areas of concern today – expectation bias remains a 'hot topic' within the controlling community and the aforementioned Defensive Controlling Guide highlights the need to reduce the rate of delivery during high RT loading, listen carefully to all read-backs and to beware the quiet period after being busy – which is a common time for errors (rather more so than during high workload). It also states that controllers and supervisors should split positions early and consider other controllers' workload thresholds. All of this sounds relevant to my own scary moment!

A wise person once said that it is good to learn from your mistakes...but it is even better to learn from the mistakes of others. I certainly learned about level busts the hard way...

EASA: new powers, new responsibilities

By Savina Zakoula, EASA Communications Officer

Operational since 2003, the European Aviation Safety Agency (EASA) is in the centre of the European Union's strategy for aviation safety. Today EASA is ready to assume new responsibilities to the benefit of European citizens and businesses.

Air transport is today the safest form of travel. It is also the fastest growing. That is why the European Union decided on a common initiative to keep air transport safe and sustainable, allowing for growth and improved safety. It is called the European Aviation Safety Agency.

Based in Cologne, Germany, the Agency's mission is to promote the highest common standards of safety and environmental protection in civil aviation in Europe and world-wide. It is the centrepiece of a new regulatory system which provides for a single European market in the aviation industry.

The European aviation safety system

The Agency has built a strong partnership with the national civil aviation authorities, who constitute the second pillar of this new European system. EASA works hand in hand with its partners in the Member States in a clear division of labour: while national authorities continue to carry out many operational tasks - such as certification of individual aircraft or licensing of pilots - the Agency develops common safety and environmental rules at the European level. It monitors the implementation of standards through inspections in the Member States and provides the necessary technical expertise, training and research.

Membership to the Agency goes beyond EU borders. In December 2006 Switzerland became the fourth non-EU country to adopt European Union aviation safety legislation after Norway, Iceland and Liechtenstein. EASA currently numbers 31 members.

EASA is publicly accountable to the Member States and to the EU institutions. All Member States and the European Commission are represented in its Management Board, while a number of consultative and advisory committees ensure the active involvement of aviation industry in the Agency's work. There is also an independent Board of Appeal.

Towards a single aviation market EASA also carries out executive responsibilities in the area of type-certification, i.e. the certification of specific models of aircraft, engines or parts approved for operation in the European Union. All EASA approvals are valid throughout its 31 member countries. The aviation industry benefits from common specifications, cost-efficient services and a single point of contact.

Current and future tasks

The main tasks of the Agency include:

- Rulemaking: drafting aviation safety legislation and providing technical advice to the European Commission and to the Member States;
- Inspections, training and standardisation programmes to ensure uniform implementation of European legislation in all Member States;
- Safety and environmental type-certification of aircraft, engines and parts, including all post-certification activities, such as the approval of changes and repairs, and the issuing of airworthiness directives to correct any potentially unsafe situation;
- Approval and oversight of aircraft design organisations world-wide as and of production and maintenance organisations outside the EU;
- Data collection, analysis and research to improve aviation safety.

JAA tasks and SAFA co-ordination

A significant step last year was the progressive take-over of the Joint Aviation Authorities (JAA) tasks and the establishment of the JAA Liaison Office in the Agency's headquarters in Cologne. Its mission is to liaise between EASA and the civil aviation authorities of the non EASA JAA Member States and to ensure the management of the rulemaking activities that have now been taken over by the Agency.

EASA also became responsible for the coordination of the European Community programme SAFA (Safety Assessment of Foreign Aircraft) regarding the safety of foreign aircraft using Community airports, and the management of the programme's central database.

2008 and beyond

In February 2008, the European legislator formally approved the extension of the Agency's scope to the areas of:

- rulemaking for air operations and flight crew licensing
- the approval of third-country (non EU) operators.

The Agency expects to assume these responsibilities in 2009, after public consultation that will take place in the course of 2008.

In a few years the Agency will also be responsible for safety regulations regarding airports and air traffic management systems.

Promoting EU standards world-wide

In parallel to its work within the EU, the Agency promotes the acceptance and recognition of EU standards and regulatory practices world-

wide. It rapidly became a major partner for civil aviation authorities and organisations, including the International Civil Aviation Organisation (ICAO), the Federal Aviation Administration (FAA) and the aviation authorities of Canada, Brazil, Israel, China and Russia. Working arrangements between the Agency and these organisations are aimed at harmonising standards and promoting best practice in aviation safety on a global scale.

Ready to assume new responsibilities

Reinforced with new powers and responsibilities, EASA aims to bring more benefits to European businesses and citizens. Common safety standards will apply to airlines and flight crews throughout the EU. Foreign aircraft will have to undergo a safety check before being allowed to operate in the EU.

Consultation on new European rules

In the following months, the details of the Agency's new responsibilities will be the subject of a wide public consultation, before legally binding rules can apply on a pan-European level. A series of Notices of Proposed Amendment (NPAs) will be published on the Agency's website, addressing the issues of: flight crew licensing, management systems, authority requirements, operations of aircraft, third country operators and the operational suitability certificate. The Agency welcomes the open discussion with all aviation stakeholders, whose views will be taken carefully into account.

Ensuring a uniform safety level for airlines flying in the EU

In the context of the extension of the Agency's scope, as of 2009 the existing "blacklist" of carriers banned from flying to Community airports will be strengthened and complimented by a pro-active, advance audit of operators wishing to fly into Europe.

This approval will guarantee common safety standards: if an approved foreign operator violates international safety standards, the approval can immediately be withdrawn and the operator will be automatically put on the blacklist until solid proof is provided that it is safe again. The SAFA programme will provide valuable information to this process.

A fast growing organisation

The Agency already employs some 400 professionals from across Europe. It will continue to recruit highly qualified specialists and administrators in the next years as it consolidates its position as Europe's centre of excellence in aviation safety.

For more information, refer to the EASA website: www.easa.europa.eu

European Strategic Safety Initiative (ESSI)

By M. Masson, PhD, EASA, ESSI Secretary

The European Strategic Safety Initiative (ESSI) is an aviation safety partnership between EASA, other regulators and the industry aiming at further enhancing aviation safety in Europe and worldwide through safety analysis, implementation of cost effective action plans, and coordination with other safety initiatives worldwide. Launched in 2006 as a ten year program, the ESSI has three components: ECAST - the Commercial Aviation Safety Team, EHEST - the European Helicopter Safety Team, and EGAST - the General Aviation Safety Team.

European Partnership

The European Aviation Safety Agency (EASA - see the article in this issue of FOCUS) launched on 27 April 2006 the European Strategic Safety Initiative (ESSI) as the successor to the Joint Safety Strategy Initiative (JSSI) of the Joint Aviation Authorities (JAA). In addition to the commercial aviation component already covered by the JSSI, the ESSI also addresses helicopter and general aviation safety.

ESSI is a voluntary and privately funded partnership between EASA, other European regulators, industry, professional unions, research organisations, military operators and the GA community. Participants come from the EASA States (27 European Union Member States plus Switzerland, Lichtenstein, Iceland and Norway) and the ECAC States. More than 150 organisations participate to date in this European aviation safety partnership. The FAA and international organisations such as AEA, EBAA, ECA, ECAC, EHAC, EUROCONTROL, GAMA, FSF, IACA, IATA, ICAO, IFA, IFALPA, IFATCA, IAOPA, GASCAO, and IBAC, are active players.

The basic principle of the initiative is that industry can complement regulatory action by voluntarily committing to cost-effective safety enhancements. Members commit to provide reasonable resources and take reasonable actions as a result of the ESSI recommendations, guidance and solutions that they contribute developing. Certain ESSI recommendations may also result in regulatory actions when appropriate, after going through the established European or national rulemaking processes.

With strong UK involvement

Among the UK or UK-based participants are the Air Accidents Investigation Branch (AAIB), Aircraft Owners and Pilots Association (AOPA), BAA Central Airside Operations, Bristow Group Inc., British Airways Plc, British Business and General Aviation Association (BBGA), British Helicopter Advisory Board (BHAB), Britten-Norman Aircraft Limited, Civil Air Navigation Services Organisation (CANSO), Civil Aviation Authority, Cameron Balloons Limited, Cessna Aircraft Company, CHC Helicopter Corporation, De Havilland Support Ltd, easyJet Airline Company Ltd, Europe Air Sports, European Airshow Council (EAC), European Helicopter Association (EHA), European Helicopter Operators Committee (EHOC), European Regions Airline Association (ERA), Flystar Astraeus, General Aviation Safety Council (GASCo), International Council of Aircraft Owner and Pilot Association (IAOPA), Light Aircraft Association, Lindstrand Technologies Ltd, Ministry of Defence, Monarch Airways, Mornington Sanford Aviation - Robinson Helicopter, National Air Traffic Services (NATS), QinetiQ, Rolls-Royce plc, Royal Aeronautical Society (RAeS), Shell Aircraft International, Sloane Helicopters Ltd, and Virgin Atlantic Airways Ltd (the list isn't exhaustive). This list demonstrates the massive UK support to the ESSI.

International Cooperation

In line with its JSSI heritage, ESSI will maintain and further develop cooperation with the Commercial Aviation Safety Team (CAST), the FAA, EUROCONTROL, the Flight Safety Foundation and ICAO Technical Co-Operation Programme (COSCAP).

The ESSI is one of the major safety teams and initiatives worldwide, such as the above mentioned CAST, the COSCAP Regional Safety Teams, the Pan American Aviation Safety Team (PAAST), the IATA African Safety Enhancement Team (ASET), and the International Helicopter Safety Team (IHST). More recently, the Middle East Aviation Safety Summit that took place in Abu Dhabi on 21-22 January 2008 took the resolution to create a Middle East Safety Team (MEST) to implement the Global Aviation Safety Roadmap in the region.

The Global Aviation Safety Roadmap (GASR) was developed in 2006 for ICAO by the Industry Safety Strategy Group lead by IATA. The Roadmap provides a reference framework for all stakeholders, including States, regulators, operators, airports, manufacturers, professional organisations, safety organisations and air traffic service providers, to guide and coordinate safety policies and initiatives worldwide. The ESSI fits well within this framework as it provides a mechanism for coordinating safety initiatives within Europe and between Europe and the rest of the world, seeking for global alignment and minimising duplication of efforts across stakeholders.

ESSI Safety Teams

ESSI has three components: the European Commercial Aviation Safety Team (ECAST), the European Helicopter Safety Team (EHEST) and the European General Aviation Safety Team (EGAST). Each ESSI team is co-chaired by a regulator and an industry member.

European Commercial Aviation Safety Team (ECAST)

Launched on 12 October 2006, ECAST addresses large aircraft operations. With more that 50 participating organisations, it is Europe's equivalent of CAST (www.cast-safety.org) in the US.

ECAST monitors implementation in Europe of the action plans inherited from the JSSI. These plans address the reduction of the risks of CFIT, Approach and landing, and Loss of Control accidents.

In parallel, ECAST has also developed a new three-phase process:

- Phase 1 – Identification and selection of safety issues,
- Phase 2 – Safety issues analysis, and
- Phase 3 – Development, implementation and monitoring of action plans.

Phase 1 started in April 2006. The objective was to identify priorities for further ECAST work based on three criteria: safety importance, coverage (the extent to which the subjects are already covered in other safety work) and high level costs benefits or impact assessment considerations.

Eighteen subjects were identified: Ground Safety, Runway Safety, Safety Management Systems (SMS) & Safety Culture, Flight Crew Performance, Loss of Control (General), Approach and Landing, Aviation System Complexity, Fire, Smokes and Fumes, Air-Ground Communications, Mid Air Collision, Control Flight Into Terrain (CFIT), Icing, Bird Strike, Loss of Control (Weight & Balance), Air Navigation, Airworthiness (Maintenance & Design), Maintenance Human Factors and Automation.

From this list of eighteen, ECAST will launch in 2008 two working groups on SMS and Ground Safety, as part of Phase 2. Resources permitting, other subjects could be addressed too, either directly or through coordination with other safety initiatives, such as the Flight Safety Foundation Runway Safety Initiative for runway safety.

One Helicopter provided by AgustaWestland

European Helicopter Safety Team (EHEST)

EHEST is the second ESSI pillar. Launched on 14 November 2006, it brings together major helicopter airframe, engine and systems manufacturers, operators, regulators, helicopter and pilots associations, research organisations, accident investigators from across Europe. A few military operators, including the UK Ministry of Defence, also participate.

EHEST is also the European component of the International Helicopter Safety Team (IHST www.ihst.org). IHST was established after the first International Helicopter Safety Symposium (IHSS) held in Montreal on 26-29 September 2005. IHST has established regional teams worldwide, including EHEST. The IHST is managed by representatives of the Helicopter Association International (HAI), the FAA, Transport Canada, and major helicopter manufacturers. Europe is represented in the IHST Executive Committee by the European Helicopter Association (EHA) and SHELL Aircraft.

EHEST is committed to the IHST goal of reducing the helicopter accident rate by 80 percent by 2016 worldwide, with emphasis on European safety.

The European Helicopter Safety Analysis Team (EHSAT) was formed by the EHEST with the purpose of analysing European helicopter accidents, using a process adapted by the Joint Helicopter Safety Team (JHSAT) from CAST. EHEST and EHSAT are committed to ensuring that the analysis carried out in Europe will be compatible with the work of the JHSAT, so that results could be aggregated at worldwide level.

More than fifty organisations participate in EHEST to date, of which around 30 are involved in EHSAT.

The data set is made of accidents occurred from 2000 onwards in States of occurrence from the EU27+4 zone, and reported in documented AIB accident reports.

One large aircraft – provided by Airbus

This has been a challenge for the EHSAT to organise and co-ordinate analysis in Europe. To tackle the variety of languages used in accident reports and optimise the use of resources, EHSAT has established regional teams in France, Germany, UK, Italy, Spain, Switzerland, Norway, Sweden, Iceland, Denmark and Finland, and is seeking to expand. So far the countries covered by the regional teams account for more than 90% of the helicopters registered in Europe.

Producing rich analyses requires combining diverse and complementary perspectives. Regional teams therefore try to present a balanced range of competences, bringing together representatives from the national aviation authority, accident investigation body, civil operators, manufacturers, pilot associations, GA and, when possible, military operators.

The accident reports are basically reanalysed, and their findings and recommendations are enriched for EHSAT use. Accident analysis is based on a sound method featuring expert opinion. Providing there is enough reasonable evidence in the reports, the analysts may exercise expert judgement to hypothetise factors that may have played a role in the accident, but that were not explicitly mentioned in the reports. Technically speaking, such factors receive lower validity and importance scores. But they may provide ideas for new, innovative safety enhancements. It is worth noticing that the EHSAT analyses don't compete with the AIB reports. The objective and context are different, as AIB reports should be limited to facts which have been substantiated during the investigation. Also, many AIBs such as the UK Accidents Investigation Branch (AAIB), the German Bundesstelle für Flugunfalluntersuchung (BFU) and the French Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA) participate in the EHSAT, which demonstrates good cooperation.

Two hundred analyses are expected by mid 2007. The results will be presented in the IHST Europe 2008 conference at Helitech, Estoril, Portugal, on 13 October.

European General Aviation Safety Team (EGAST) The foundation meeting of the European General Aviation Safety Team (EGAST) took place at EASA on 17 October 2007 and was attended by over 60 representatives of the General Aviation community from across Europe.

One GA aircraft – by AERO Vodochody

"General aviation has a high priority for the European Aviation Safety Agency. EGAST is a new venture in Europe and a challenge. The Agency welcomes the wide participation of the aviation community, as part of its overall efforts to revitalise General Aviation", said Patrick Goudou, Executive Director of EASA at the opening session.

General aviation is a dispersed community made of very diverse components such as business aviation, aerial work, air sports and recreational activities. Recreational aviation itself features a wide spectrum of airborne activities ranging from powered flying, ballooning and gliding to micro light flying, paragliding and hanggliding. EGAST responds to the need for a coordinated European effort.

It is the first time that such a partnership for general aviation safety is launched in Europe. It gathers representatives of manufacturers, regulators, aero-clubs, accident investigators, national and international authorities, safety foundations, pilots associations, research organisations, and the entire GA community.
EGAST is organised in three layers representing various levels of involvement: EGAST Level 1, the EGAST Core Team, defines and runs the work programme. It is composed of around 20 members reflecting the different GA sectors. EGAST Level 2 is composed of around 60 organisations, which form a sounding assembly. This assembly meets every two years. EGAST Level 3 is the global European GA community, which needs to be informed of the EGAST work.

Building on the national General Aviation initiatives in Europe, EGAST creates a forum for promoting safety, improving data collection and analysis, and sharing best practices, including on safety management. As defined by the Core Team on 29 November 2006, the objective will be to "actively promote best practices and awareness for all sectors of General Aviation, in order to improve safety, thereby reducing accident rates."

Conclusion

These three ESSI teams have become an active part of the aviation safety landscape in Europe. The ESSI is an ambitious, 10 year programme aimed at improving safety in Europe and for the European citizen worldwide. The ESSI is an industry-regulators partnership, facilitated but not owned by EASA. Securing participation and commitment was the challenge in the first years of existence. The initiative is now up and running. The next challenge is working together to make a difference.

Further Reading

For further information refer to the ESSI web-site: www.easa.europa.eu/essi

Engine Power Loss in Ice Crystal Conditions

by Jeanne Mason, Senior Specialist Engineer, Engine Performance and Operability, Propulsion System Division

High-altitude ice crystals in convective weather are now recognized as a cause of engine damage and engine power loss that affects multiple models of commercial airplanes and engines. These events typically have occurred in conditions that appear benign to pilots including an absence of airframe icing and only light turbulence. The engines in all events have recovered to normal thrust response quickly. Research is being conducted to further understand these events. Normal thunderstorm avoidance procedures may help pilots avoid regions of high ice crystal content.

Since 1990, there have been at least 100 jet engine power-loss events on both commuter and large transport airplanes, mostly at altitudes higher than 22,000 feet, the highest altitude where airframe icing is expected to exist. "Power loss" is defined as engine instability such as a surge, stall, flame-out, or rollback that results in a sub-idle operating condition. High-altitude ice crystals are believed to have caused most or all of these events.

This article explains the ice crystal phenomenon how ice crystals cause power loss, the types of power-loss events, where and when engine power-loss events have occurred, conditions associated with ice crystal formation, and recommendations for flight near convective weather. It also discusses the importance of pilot reporting of ice crystal power-loss events.

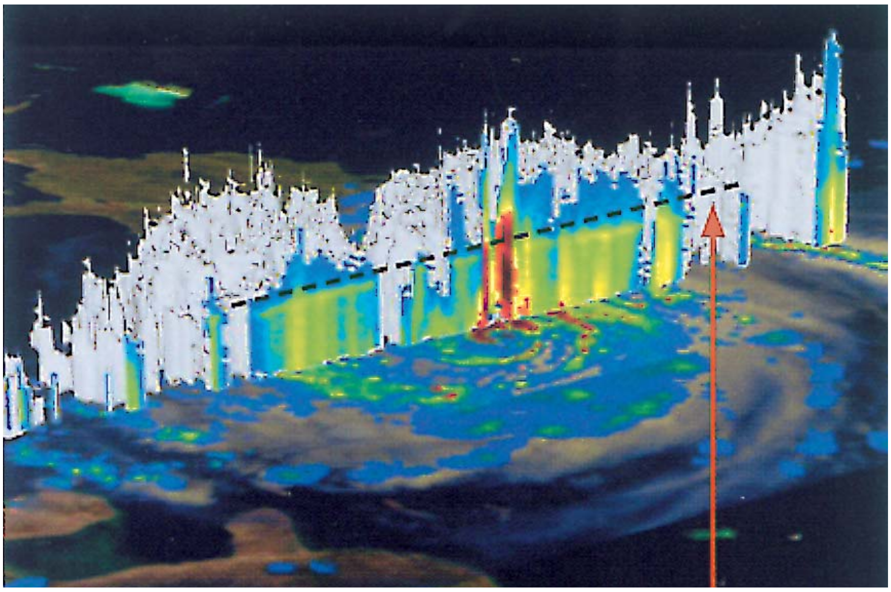


Photo Credit: NASA TRMM
Image by Hal Pierce (SSAI/GSFC)

Satellite/Radar image of a hurricane convective storm *– Figure 1*

This NASA Tropical Rainfall Measurement Mission (TRMM) combined satellite radar image shows a verticle cross-section of a convective storm. The image shows the freezing level clearly by the "bright band" where ice particles become coated with melted water and are excellent reflectors of radar energy. Below the freezing level, liquid water is highly reflective. Above the freezing level, while the concentration of moisture may still be high, the cloud is mostly composed of frozen ice particles with radar reflectivity below 20dBZ (units of radar energy). Small ice crystals are irregular in shape and poor reflectors of radar energy. These small ice crystals are believed to be associated with engine power-loss events.

High–Altitude Ice Crystal Icing

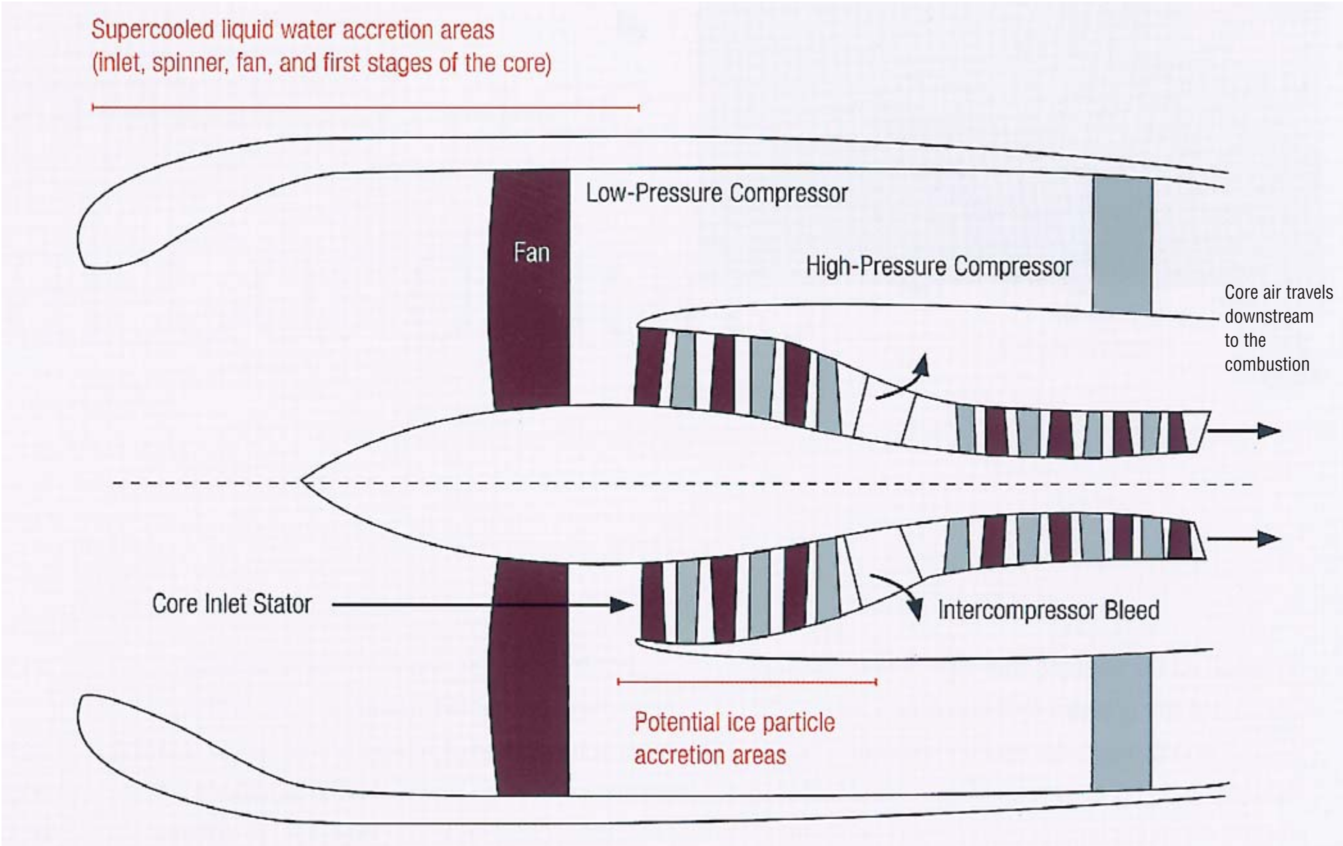
Several engine power-loss and damage events have occurred in convective weather above the altitudes typically associated with icing conditions. Research has shown that strong convective weather (thunderstorm activity) can lift high concentrations of moisture to high altitudes where it can freeze into very small ice crystals, perhaps as small as 40 microns (the size of flour grains). These are the crystals that can affect an engine when flying through convective weather. The Industry is using the phrase "ice crystal icing" to describe these icing conditions, and to differentiate it from icing conditions due to supercooled liquid.

Ice crystals do not adhere to cold airframe Surfaces because the ice crystals bounce off. However, the crystals can partially melt and stick to relatively warm engine surfaces.

"Glaciated conditions" refers to atmospheric conditions containing only ice crystals and no supercooled liquid. "Mixed phase conditions" refers to atmospheric conditions containing both ice crystals and supercooled liquid. Both glaciated and mixed phase conditions occur in convective clouds and have been present during engine power-loss and damage events.

On-board weather radar can detect large particles such as hail, rain, and large ice crystal masses (snowflakes). Small particles, such as ice crystals in high concentrations near thunderstorms, are invisible to on-board weather radar, even though they may comprise the majority of the total mass of a cloud (see fig. 1).

Sophisticated satellite radar technology has been used to detect crystals smaller than the lower limit of on-board weather radar. Above the freezing level, where icing can occur in a deep convective cloud, satellite radar has confirmed that large particles, which can be detected by on-board weather radar, are only found near the convective precipitation core. Away from the convective precipitation core, satellite radar has confirmed that small ice crystals, which are invisible to on-board weather radar, exist. For this reason, flight in visible moisture near deep convective weather, even without radar returns, and at temperatures below freezing, is very likely to be in ice crystal conditions.



***How Ice crystals accrete in a jet engine** – Figure 2*
Researchers hypothesize that ice particles enter the engine and bounce off surfaces colder than freezing (inlet, fan, and spinner). Once reaching surfaces warmer than freezing in the core, some of the small particles can melt and create a film of water on the surface to which additional incoming ice crystals can stick. This process gradually reduces the temperature of the surface until ice can begin to build up.

Ice building up on the inlet, fan, or spinner would likely shed outward into the fan bypass duct without causing a power loss. Therefore, in these power-loss events, it is reasonable to conclude that ice must have been building up in the engine core.

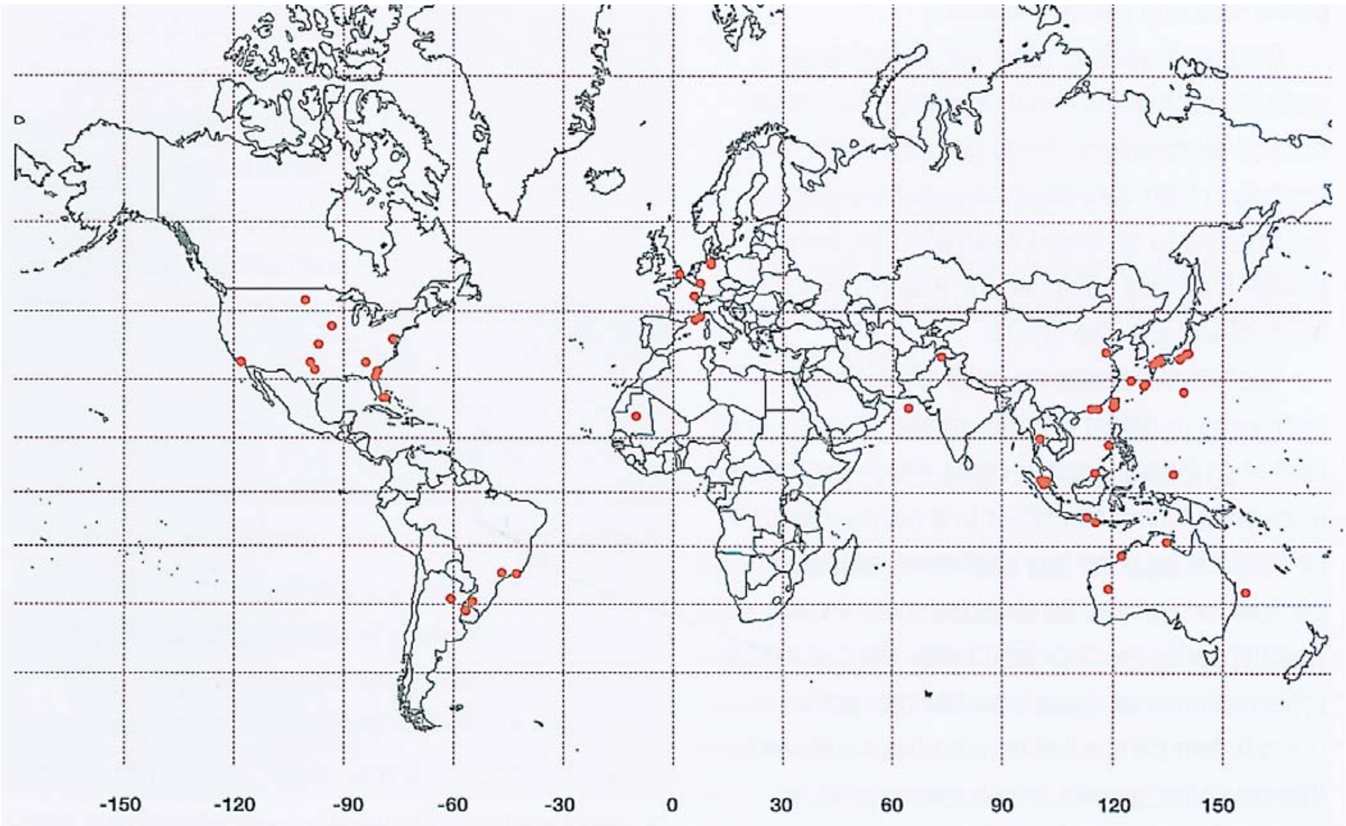
Power-Loss Type	Description	Effect	Recovery
Surge/Stall**	Ice shed into compressor drives engine to surge, then stall causes rotor speeds to decay, and reducing airflow while combustor remains lit.	Thrust loss and high exhaust gas temperature.	Throttle to idle. Cycling of the fuel switch may be required to clear some stalls.
Flameout*	Ice shed into the combustor quenches the flame.	Thrust loss and all parameters dropping.	Ignition. Many events self-recover due to auto-relight or having the ignition already on.
Engine Damage	Engine blades become damaged as shed ice impacts them.	Typically no effect at time of initial damage, but damaged blades may fail later causing vibration or engine stall.	As appropriate – refer to Quick Reference Handbook.

In every large transport power-loss event occurring due to stall and flameout that has been tracked to date, the engines were successfully restarted.

It is now believed that ice crystal icing can occur deep in the engine where surfaces are warmer than freezing (see fig. 2). Both older generation jet engines and the new generation of jet engines (high bypass ratio engines with electronic engine controls) can be affected by ice crystal icing.

Types of Power-Loss Events

The actual mechanism for ice crystal-related engine power loss takes many forms, depending on the design characteristics of each particular engine type (see table **).



Locations of ice crystal power-loss events *– Figure 3*

While most ice crystal power-loss events that have been studied to date have occurred in Asia, events have been noted in most parts of the world. Note: Latitude and longitude information is not available for all 100 events. This chart actually shows 67 events, some of which are overlaid. Not all events are Boeing airplanes.

Where and when Ice Crystal Power-Loss events have occurred

About 60 percent of recorded ice crystal power-loss events have occurred in Asia. Researchers speculate that this may be due to the fact that the highest sea surface temperatures are also found in this region. Higher temperature air can hold more water. There is a heavy concentration of crystal power-loss events between 20 and 40 degrees north latitude with a few events farther than 45 degrees from the equator (see fig. 3).

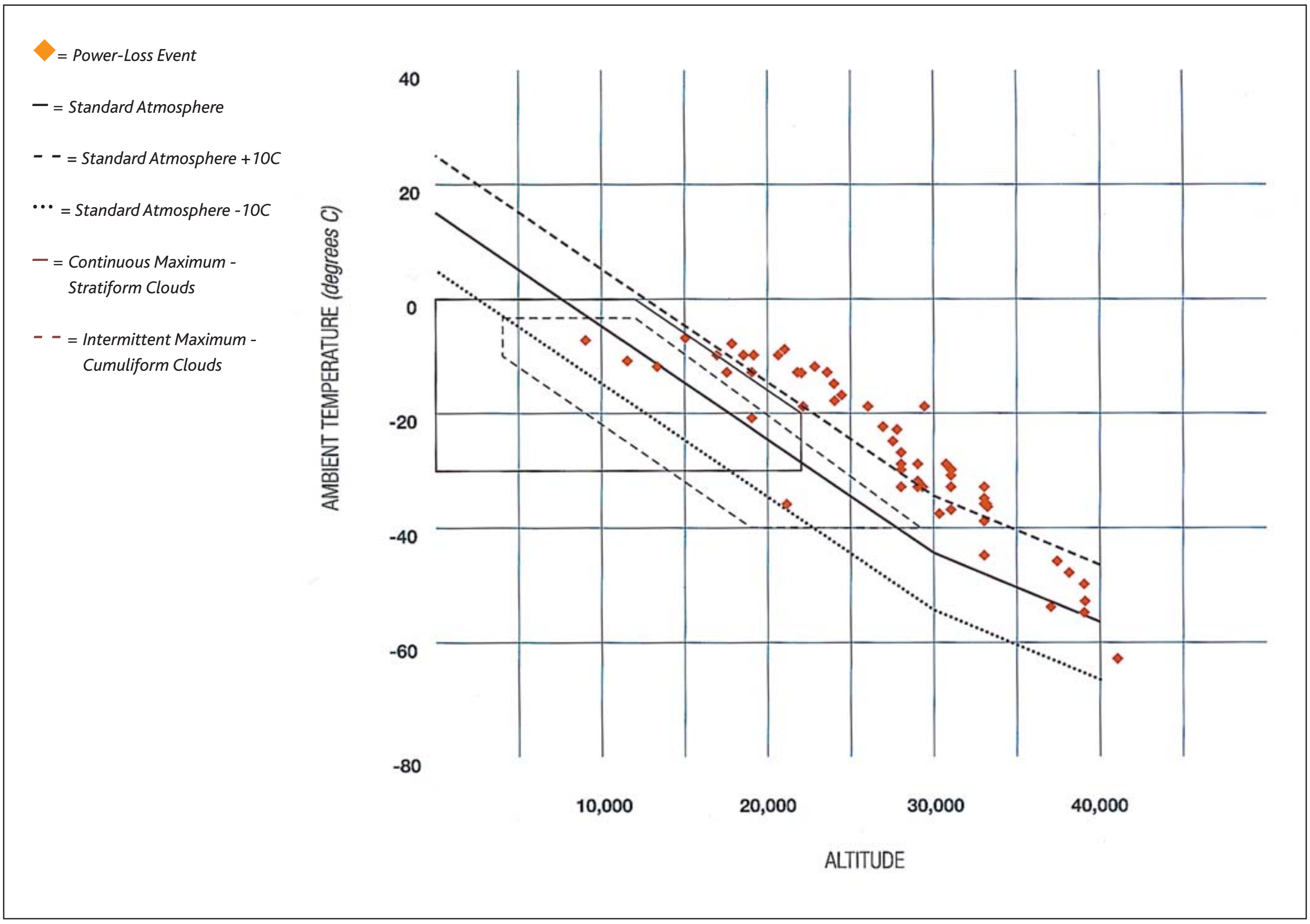
Engine power-loss events have occurred in three phases of flight: climb, cruise, and descent. However, most events occur during the descent phase, most likely because of a combination of two factors. First, for icing to occur, the ambient temperature must be below the freezing level, and therefore icing tends to occur at the higher altitude associated with the descent phase. Second, the engine is least tolerant to ice shedding at idle power, which occurs in the descent phase. Icing at high power and high altitude is possible due to the existence of high concentrations of ice crystals for long distances, such as in the anvil of a large convective storm, and the fact that ice can build up on warm engine surfaces.

Recognizing High Ice Crystal Conditions

Researchers have identified several conditions that are connected to engine ice crystal icing events. The most important factors are:

- *High altitudes and cold temperatures.* Commercial airplane power-loss events associated with ice crystals have occurred at altitudes of 9,000 to 39,000 feet, with a median of 26,800 feet, and at ambient temperatures of -5 to -55 degrees C with a median of -27 degrees C. The engine power-loss events generally occur on days when the ambient temperature is warmer than the standard atmosphere (see fig. 4 on page 18).

- *The presence of convective clouds.* Convective weather of all sizes, from isolated cumulonimbus or thunderstorms to squall lines and tropical storms, can contain ice crystals. Convective clouds can contain deep updraft cores that can lift high concentrations of water thousands of feet into the atmosphere, during which water vapor is continually condensed and frozen as the temperature drops. In doing so, these updraft cores may produce localized regions of high ice water content which spread downwind. Researchers believe these clouds can contain up to 8 grams per cubic meter of



***Altitude and temperature occurrence of engine loss** – Figure 4*

Temperatures for the majority of the events for which data is available are significantly warmer than standard day temperatures, and also fall outside of the current icing design envelopes for supercooled liquid water.

ice water content; by contrast, the design standard for supercooled liquid water for engines is 2 grams per cubic meter.

- *Areas of visible moisture above the altitudes typically associated with icing conditions*. This is indicated by an absence of significant airframe icing and the ice detector (when installed) not detecting ice, due to its ability to detect only supercooled liquid, not ice crystals.

These additional conditions are also typically found during engine ice crystal power-loss events.

- No pilot reports of weather radar returns at the event location.
- Temperature significantly warmer than standard atmosphere.
- Light-to-moderate turbulence.
- Areas of heavy rain below the freezing level.
- The appearance of precipitation on heated windshield, often reported as rain, due to tiny ice crystals melting.
- Airplane total air temperature (TAT) anomaly reading zero, or in error, due to ice crystal buildup at the sensing element (see case study on following page).
- Lack of observations of significant airframe icing.

Recommendations for Flight near Convection

Even when there are no radar returns, there may be significant moisture in the form of ice crystals at high altitudes. These are not visible to airborne radar. As a result, it is not possible to avoid all ice crystal conditions. However, normal thunderstorm avoidance procedures may help pilots avoid regions of high ice crystal content. These avoidance procedures include:

- Avoiding flying in visible moisture over storm cells. Visible moisture at high altitude must be considered a threat since intense storm cells may produce high concentrations of ice crystals at cruise altitude.

- Flying upwind of storms when possible.

- Using the radar antenna tilt function to scan the reflectivity of storms ahead. Assess the height of the storms. Recognize that heavy rain below the freezing level typically indicates high concentrations of ice crystals above.

- Avoiding storm reflectivity by 20 nautical miles has been commonly used as a recommended distance from convection. This may not be sufficient for avoidance of high concentrations of ice crystals, as they are not visible on airborne radar.

These recommendations are included in flight operations technical bulletins Nos. 707-06-1, 727-06-1, 737-06-1, 747-15, 747-400-55, 757-75, 767-75, 777-21, 787-1 issued by Boeing on August 1, 2006: *Convective Weather Containing Ice Crystals Associated with Engine Power Loss and Damage*.

Further Research

Today, knowledge of the nature of convective weather and the exact mechanism of ice crystal buildup and shedding in the engine is limited. A research program is being developed by an industry icing group to address these needs. It involves flights into convective clouds to measure their properties, as well as ground-based engine testing.

Most of what is currently understood about the environment associated with engine events is based on pilot reports and flight data. Additional pilot reports of high-altitude ice crystal encounters (with or without engine events) will help researchers understand the conditions associated with engine events, ensure that the flight program is directed into the appropriate flight conditions, and help develop cues for these flight conditions.

Pilots encountering conditions such as those described in this article are encouraged to provide as many details about the conditions as possible to their airlines for subsequent use by researchers.

Summary

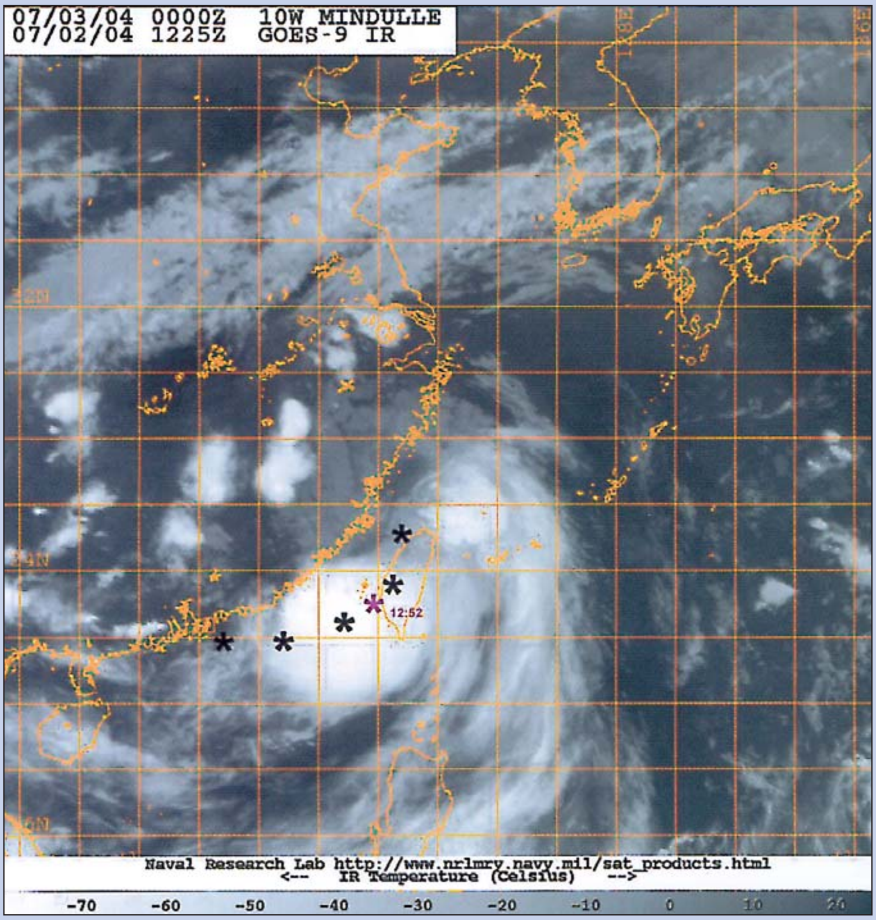
Ice crystal icing conditions have been recognized as a hazard to turbofan engines. Ice can build up deep in the engine core.
Pilots are advised to familiarize themselves with the conditions under which ice crystal icing typically occurs and follow the recommendations in related technical bulletins.
Airline awareness of the potential for ice crystal icing on all engine models/airplane types may provide additional information that will help Boeing and the industry better understand this phenomenon.

For more information, please contact Jeanne Mason at jeanne.g.mason@boeing.com.

Material for this article has been drawn from AIM 2006-0206 Ice Particle Threat to Engines in Flight, Mason, Strapp and Chow.

An Ice Crystal Power-Loss event case study

- A commercial airplane on descent, flying in convection conditions, experienced a TAT anomaly. (The anomaly is due to ice crystals building up in the area in which the sensing element resides, where they are partly melted by the heater, causing a 0 degrees C reading. In some cases, TAT has stabilized at 0 degrees C during a descent, and may be noticeable to pilots. In other cases, the error is more subtle, and not reliable-enough indicator to provide early warning to pilots of high concentrations of ice crystals.)
- At 38,000 feet (-42 degrees C), the pilot encountered moderate turbulence and noted some lightning in the vicinity.
- A brief power-loss event occurred at 30,000 feet – the engines restarted quickly.
- There were no radar echoes at the altitude and location of the airplane.
- An absence of a response from the ice detector indicated that no supercooled liquid was present.
- The pilot reported heavy rain at –25 degrees C.
- Initial report of rain on the windscreen was later determined to be ice crystals, and confirmed by the pilot to have a unique sound.



Infrared image with airplane track

In this infrared satellite image from about the time of an engine event, bright white indicates colder cloud, and therefore at high altitude. The airplane penetrated the upper altitudes of a fully developed typhoon, yet the pilot did not see any flight level radar returns.

The asterisks represents the aircraft path from left to right on decent into Taipei, with the event noted in purple.

To view enhanced media associated with this article, visit AERO *online at www.boeing.com/commercial/aeromagazine.*

The Management of Aviation Safety Risk in the MOD

This article was written by the Air Safety Management Staff Officer, Squadron Leader Kevin Keen MEEng MSc RAF from the Defence Air Safety Centre (DASC) and was published in a recent DASC Air Safety Magazine. Although it discusses the way ahead for management of aviation safety risk in the Ministry of Defence, it provides a clear explanation and useful model for those starting to get to grips with the subject beyond the military environment.

Rich Jones

'If you are looking for perfect safety, you will do well to sit on the fence and watch the birds', Wilbur Wright

'If there were no risks it probably would not be worth doing', Steve Ishmael - NASA test pilot.

Aviation is a risky business and it is true to say that military aviation is inherently more risky than its civilian counterpart. Servicemen, particularly aviators, accept an increased exposure to risk as part of their responsibility. From the opening quotes, it should also be noted that risks can not be eradicated if we wish to continue our activities. But what is risk? For a term that is widely used it is not often widely understood. And if an increased level of risk is in the line of duty, how much additional risk should be accepted? Should it be based on pay, task or even aircraft? What is the balance between the safety of the individual and the necessity of the task being carried out? Can it even be quantified?

A fundamental part of Aviation Safety Management (ASM) is Risk Management (RM). One of the tasks of the DASC ASM Branch is to hold and compile the Defence Aviation Safety Strategic Risk Register. In consideration of this task the questions stated earlier arose and are worthy of further airing. Through this article I aim to look at risk, the key concepts surrounding it and argue for a sanctioned definition of the tolerable level of safety within Defence Aviation as an aid to RM and decision making.

Risk Management – Predicting the future

JSP 525[1] is the manual for overall Risk Management (RM) and risk reporting in the MoD. It defines risk as *"A future uncertain event that could adversely influence the achievement of departmental objectives and statutory obligations."* This means that, basically, risk management is about the prediction and control of unwanted future events arising from the activities we want to do. Therefore, when we say an activity is risky, what we mean is that the risk connected with some future unwanted outcome is high. Risk assessment is a vital part of ASM as R440.100.1 of JSP 550 states that 'all military and civilian personnel have a legal duty to assess the risks from their work activities whether this involves flying… or any other activities associated with military aviation.'

Risk itself is made up 2 components: severity, a measure of the impact of an unwanted event should it happen and likelihood, a measure of the probability of the unwanted event occurring. Clearly high risks are attached to events that have a severe impact, a great likelihood, or more probably both, and the reduction of one component can mitigate against the other to reduce overall risk, as shown in the simple Risk Classification Matrix at Figure 1. For example, despite the fear generated in some people, the activity of flying in a civilian airliner is not considered risky because the likelihood of a particularly catastrophic event - an aircraft crash for example - is deemed sufficiently improbable. Thought about this way, risk is a very easy concept to understand; unfortunately, it is very difficult to apply in a practical and objective manner.

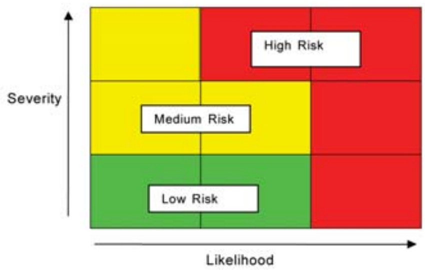


Figure 1 *– Simple Risk Classification Matrix*

Are you ALARP?

One of the difficulties of RM within military Aviation Safety (AS) and, indeed, safety generally is that risks have to be reduced 'As Low As Reasonably Practicable' (ALARP), which is not a constraint applied to RM in non-safety areas such as project risk. The ALARP principle has been part of safety legislation in the UK, and therefore MoD policy, for many years. It is a fascinating and deceptively simple concept that allows risks to be balanced against forms of cost, which includes costs in terms of operational impact as well as those costs that are purely financial. Crucially, using the ALARP principle, we can no longer say that 'safety is paramount'. What we have to do is ensure that risks are reduced ALARP for an activity rather than override that activity. This corrects the risk averse nature of previous safety statements, but the freedom thus gained is paid for in the work involved in the application of the Cost-Benefit Analysis (CBA) required.

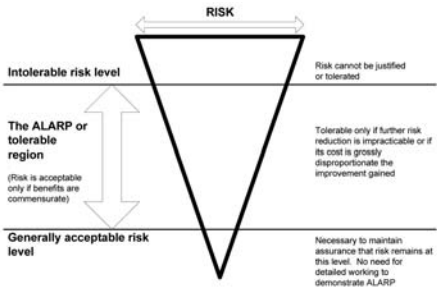


Figure 2 *– The ALARP Principle*

Figure 2 shows the so-called ALARP carrot, which shows that risks can broadly be categorized into one of 3 regions: the intolerable region where risks are considered so high that the activity should not be continued; the broadly acceptable region, where risks are considered generally low enough not to require further risk reduction[2] and the ALARP region, where risks are considered tolerable as long as further reduction is considered impracticable or the costs of the risk reduction are grossly disproportionate to the safety benefit gained. Sounds great, but there are some real practical headaches in applying the ALARP principle: how do you prove ALARP, what is grossly disproportionate, how do you measure costs and benefits in a way that they can be compared and who decides what is tolerable, intolerable and broadly acceptable?

Luckily, ALARP is not just about number crunching. One can also demonstrate that risks have been reduced ALARP by the application of good practice, such as:

1. Prescriptive legislation.
2. HSC/HSE Approved Codes of Practice and guidance.
3. Approved international or national standards.
4. Guidance agreed by a body (e.g. trade federation or professional institution) unless in conflict with (1)–(3).
5. The standard practice adopted by an industrial/occupational sector, unless in conflict with (1)–(4).

Although this is possibly a simpler way of applying ALARP, the leeway offered to the MoD as a self regulator is threatened by the application of good practice under the ALARP principle.

From the above, it can be seen that the application of the ALARP principle is dependent on the expression of the tolerability and acceptability of risks and the ability of comparing safety benefits with costs with a degree of commonality. Alternatively and additionally, the use of identified good practice can be used for demonstrating ALARP. The flexibility inherent in the ALARP principle is offset, however, by the work necessary in its application and, to an extent, the threat it poses to self-regulation. It remains, however, a necessary part of RM, which adjusts the simple Risk Classification Table to that shown in Figure 3.

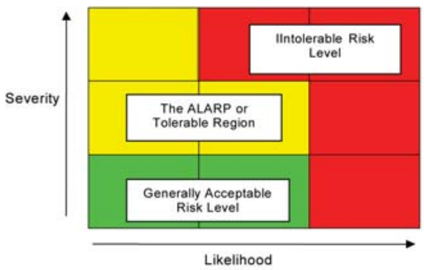


***Figure 3** – The ALARP Principle Superimposed on the Simple Risk Classification Matrix*

Risk reporting in the MOD

The MoD's Departmental Plan (DP) 2005-2009 states that 'effective management of risk is crucial to the delivery of the MOD's strategic objectives... with effective risk management processes in place at every level of the Department.' The MoD's objectives are stated in the form of the Balanced Scorecard (BSc), with the delivery of objectives delegated appropriately and risks assessed with respect to their threat to these objectives. When reporting to the Defence Management Board (DMB) severity, likelihood and risk classification are mandated and represented using the familiar 'traffic light' system. Consequently, this form of risk reporting is objective, officially sanctioned and clear.

The Defence Environmental and Safety Board (DESB) is responsible to the DMB for oversight of safety and environmental protection. The Defence Aviation Safety Board (DASB) is the functional Board with specific responsibility for Defence Aviation under the DESB and both the DESB and DASB align their risk reporting to the DMB using JSP 525. Alignment is essential as it allows AS risks to be discussed at the highest departmental levels in a common way, in order to fulfil the MoD's aims as represented within the BSc. Clearly, the potential loss of aircraft and their crews would be a major source of risk to many BSc objectives such as:

1. Current operations – loss of aircraft and crews would limit operational capability, particularly in the short term.
2. Finance – accidents have a very serious financial effect on expenditure plans.
3. Reputation – aircraft accidents and incidents, particularly involving civilians, are damaging to the reputation of the MoD and could be a threat to its self-regulating status.

However, the effect of individual aircraft accidents on the above would vary widely depending on a great many factors and it would be difficult to easily demonstrate the MoD's intolerance of aviation accidents, or measure AS performance, through them. In the short term it is probably more practical for a BSc objective to be included in the DP specifically covering AS. This objective should ideally enable practical risk assessment in a safety sense and should include the ability to demonstrate that risks have been reduced ALARP.

Risk Comparison – use of a tolerable level of safety

It could be argued that our objective for AS has already been set at zero accidents. This is reasonable and laudable as an aspiration but does not honestly reflect the risk involved in Defence Aviation, where there have been an average of around 10 aircraft accidents a year for the past 10 years or so (in itself a historically low figure). A more realistic, yet still morally defendable, approach is to aim for a year on year reduction in aircraft accidents. But how is this to be achieved via RM?

One potential answer is to add practical detail to the basic concepts outlined under the ALARP principle, in particular the setting of tolerable and acceptable levels of safety for Defence Aviation. These can then be used to inform AS risk classification using the process detailed within JSP 551 Vol 3[3] to allow RM to be conducted to a common standard.

This was the purpose of a study[4] done by a respected safety consultant, Adelard, on behalf of ADRP[5], to aid airworthiness decision-making in aircraft acquisition and sustainment. The study reviewed the number of Cat 4 and 5 accidents over a 10-year period (1991-2000 inclusive) for all aircraft types then currently in service and the tolerable level of safety for aircrew was derived, based on the view that the current[6] rate was close to the dividing line between what is tolerable and intolerable. Interestingly, this view was based on what the study stated to be 'broadly acceptable to society, as despite the publicity surrounding incidents there does not appear to be pressure to reduce them.' Acceptable levels of safety were derived from Health and Safety Executive (HSE) guidelines for acceptable risks in industry. In addition to aircrew, tolerable and acceptable levels of safety were also derived for 2nd parties[7] and 3rd parties[8] to cover all who are involved in, or could be affected by, Defence Aviation.

The levels of safety were expressed in terms of the Risk of Death (RoD) in any year, a measure that allows comparison with other activities and HSE guidelines. The figures derived in the study are shown in Table 1 with other HSE sourced RoD figures shown in Table 2 for comparative purposes.

Although the starkness of a fast jet crewman's just tolerable/intolerable RoD of 1 in 230 per year seems deeply disconcerting, it should be noted that this is not a safety target, rather an expression of tolerability, based on past experience, to aid practical RM using the ALARP principle. What should be the safety target where risks are reduced ALARP would be the acceptable level of RoD of 1 in 10,000 per year.

Practical RM and decision making

The RoD figures in Table 1 are replicated in the Defence Aviation Safety Management System (DASMS), which is now R445 of JSP 550 . The intention at the moment is to use the RoD figures only for airworthiness decision-making; indeed they are already being used by some aircraft IPTs who are basing aircraft procurement and sustainment programme decisions on the Adelard study as refined by ADRP. However, an officially sanctioned statement of a tolerable level of AS for all of Defence Aviation allows the following benefits to be derived:

1. An honest and official recognition that Defence Aviation is a risky business, with a quantification of that risk.
2. A connection could be made to a whole AS target within the DP.
3. A common risk boundary is given which can be used for standardized RM - it is not left to subjective assessment.

Boundary	Timescale	Risk of death per year First party	Second party	Third party	Societal risk
Intolerable/Just Tolerable	Immediately applicable for fast jets	1 in 230	1 in 1000	1 in 10 000	1 societal accident in 50-100 years
	Immediately applicable for helicopters	1 in 390			
	Immediately applicable for large multi-engined	1 in 640			
	Immediately applicable for trainers	1 in 1000			
	2010 (except trainers)	1 in 770			
	2050	1 in 1000			
	All future procurements	1 in 1000			
Broadly acceptable	Immediately applicable	1 in 10 000	1 in 100 000	1 in 1000 000	

Table1 - The Intolerable and Broadly Acceptable RoD for all Affected by Defence Aviation

Cause	Annual Risk of Death (over entire population)
All causes	1 in 97
Cancer	1 in 387
HSE Guideline for Workers	1 in 1000
Commercial divers	1 in 2700
Injury and poisoning	1 in 3,137
All types of accidents and all other external causes	1 in 4064
All forms of road accident	1 in 16,800
Lung cancer caused by radon in dwellings	1 in 29,000
Lightning	1 in 18,700,000

Table2 - Annual Risk of Death for Various Causes[9]

4. ALARP considerations are inherent, which is essential for risk reduction in a safety context.
5. A statement for continuous improvement can be made.
6. As an explicitly stated starting point, the tolerable level of AS can be subjected to scrutiny, reviewed and improved.

However, it is accepted that there are practical difficulties in applying the figures in risk assessment, particularly in the operating environment as opposed to their use across airworthiness. How does one assess a routine training sortie in terms of its RoD for all parties? A similar problem is faced by the airworthiness community but this is a more natural sphere for the quantitative application of ALARP because of the greater certainty involved in the measurement and prediction of unwanted events with material rather than of humans. That said, RM within an operational environment is being carried out using tolerable levels of safety by ATC and ASACS controllers using broad bands of severity, likelihood and risk classification in a terminology that is useful to them, from tables derived initially from, and with continuing reference to, civilian best practice.

Progress in this area of standardized RM in the operational environment may be slow, but in general we move forward in small proven steps and through spreading good practice progress will be enhanced. Clearly, risk assessment requires time and the time allowed for AS decisions defines the level of assessment that is practical; this is a fundamental principle of JSP 551 Vol 3. RM adds most value when assessing activities with a degree of novelty and it is particularly important that it is applied to changes, be they of tasking, procedures or organization. It is also important to note that RM is a process; the risk mitigation control (whether it is a procedure, training input, equipment enhancement or even operational restriction) is the end product and the process either produces a sensible control or it does not. It is the risk assessor who is in control of the process, not the other way around. Clearly, people who apply RM should have some expertise in the area they are assessing in order to ensure this.

Conclusion

Risk is implicit in military life and particularly so in Defence Aviation. Management of this risk is a legal duty for the MoD and its employees, is mandated through JSP 550 and is a fundamental part of ASM. The MoD is an organization that uses RM extensively in the management of its activities but RM is a complex activity that needs to be tailored so that its benefits can be applied throughout the organization in its very diverse activities and structures. The definition of tolerable and acceptable levels of safety add direction to the RM process and allow the MoD to declare how much risk its personnel can be exposed to in order for those people to realistically do their jobs. The practical application of levels of safety are problematical but possible; within the MoD this is already being achieved in some areas. By identifying and spreading best practice inside and outside the MoD we can apply RM to enhance our operational capability in a way that is practical, yet defendable, both legally and morally.

1 Corporate Governance And Risk Management
2 Although this should be done if benefits are cost effective.
3 Military Aviation Risk Management.
4 Numerical Criteria for Airworthiness - Adelard 20 Sep 02.
5 Airworthiness, Design Requirements and Procedures - Sponsors of JSP 553: Military Airworthiness Regulations.
6 At the time of the study - 2002-3.
7 Personnel who spend a great deal of time as pax on military aircraft, maintainers etc.
8 People uninvolved with the purpose of the aircraft or pax who do not fly frequently.
9 Taken from Reducing Risks, Protecting People, HSE 2001 and other HSE sources.
10 Military Aviation Policy, Regulations and Directives.
11 See http://y4.dpa.r.mil.uk/kb/Organisati/SGs/ALTG/Safety/Aviation-S/Cost-Benefit-Analysis.doc_cvt.htm for guidance.

EXT 1/2008	Safety in the North Atlantic

ICAO North Atlantic Working Groups composed of State regulators, Air Traffic Control and representatives of the airspace users have concerns over repetitive errors that may impact upon the safety of Oceanic airspace.

These errors include Large Height Deviations and Gross Navigation Errors. Operators are reminded that such errors pose a threat to overall flight safety in oceanic airspace.

This bulletin has been issued to remind crews that they must adhere to their Oceanic clearance and it is recommended that this information forms part of initial and recurrent ground training to improve safety within Oceanic areas and reduce these errors.

Large Height Deviations (LHDs)

Ensure correct understanding of climb/descent

A Large Height Deviation occurs when an aircraft deviates from their cleared level by 300 feet or more. There are two common causes of LHD:

1. Aircraft entering MNPS airspace at an incorrect level. It is the Pilot's responsibility to ensure they cross the oceanic boundary at the cleared flight level. If there is any doubt then **check with ATC**.

2. Climb/descent without ATC clearance or failure to climb/descend as cleared. Crews must ensure a correct understanding of when a climb/descent should be initiated or completed. If a level change includes the word 'BY', the level change must be completed at or before the position or time stated. Again, if in doubt **check**. Such restrictions are applied to separate traffic, and failure to comply precisely with the restriction is likely to result in loss of separation with other aircraft.

Gross Navigation Errors (GNEs) and lateral deviations

A Gross Navigation Error occurs when an aircraft deviates from their cleared routing by 25 nautical miles or more. An intervention occurs when ATC corrects a potential GNE or lateral deviation from cleared track.

Fly the clearance, **not** the flight plan

70% of all lateral deviations and interventions in 2007 occurred because the pilot flew the flight plan co-ordinates instead of the clearance. It is an ICAO recommended practice that all clearances, particularly those involving a re-route should be checked by both pilots when programming the FMS or LRNS. Recent efforts to emphasise that pilots should "fly the clearance, **not** the flight plan" indicate that some improvements have been made in this area.

Most GNEs are detected at the oceanic exit point or during the first route segment after oceanic entry. Crews should be aware that they must follow the whole routing in the clearance regardless of their filed flight plan.

NATS safety notice
NATS safety notice

EXT 1/2008	Safety in the North Atlantic

Strategic Lateral Offset Procedure (SLOP)

This procedure was developed to increase the lateral separation between aircraft with very accurate navigation systems or in case of operational errors involving the ATC clearance.

Consider flying SLOP

Operators are requested to adopt SLOP as a Standard Operating Procedure (SOP) for all oceanic crossings for safety reasons, in accordance with the recommendation of ICAO.

This procedure requires aircraft to fly either the centreline, 1NM or 2NM right of centreline. No left offsets are permissible in the NAT. Aircraft that do not have an automatic offset capability (i.e. one that can be programmed in the LRNS) should fly the centreline only. Pilots must return to the centreline by the Oceanic exit point.

Aircraft are not necessarily required to maintain their lateral offset but may switch between the centreline and the offsets at any time from entry point to exit point. SLOP can be used not only for avoiding wake turbulence, but also to mitigate against vertical separation loss. For the operator, SLOP costs nothing but is priceless in terms of safety.

Feedback from major carriers who have adopted this practice during crew recurrence training on SLOP is that the resulting uptake is very good. If SLOP uptake can be increased from the current estimated 27% to the optimal of 66% flying 1NM or 2NM to the right of centreline, then analysis shows that the vertical collision risk could be significantly reduced.

If lateral deviations and interventions can be reduced and there is a significant increase in the uptake of SLOP, separation between aircraft may be reduced to allow more aircraft to fly at economical levels.

Further information can be found at www.nat-pco.org

Produced by Division of Safety
Contact: Richard Schofield
Tel: 01489 615310

Effective Date: 22/02/08

Level Busts – a questionnaire

Level busts (a deviation of 300' or more from a cleared flight level or altitude) continue to be a significant safety risk to aviation. 437 were recorded in UK airspace by NATS during the 12 month period 01 Jan 07 – 31 Dec 07, including 29 which resulted in a loss of separation.

NATS in conjunction with the UK Level Bust working group and many operators has conducted much work to determine the causes of, and ways of preventing level busts, however there remains a lack of information relating to flight deck activities during these events.

In order to obtain more information on the flight deck factors surrounding these events, NATS has produced a questionnaire aimed at pilots involved in level busts. If you are unfortunate enough to experience a level bust, please look out for this questionnaire - which should be made available via your flight safety department. Please take a few minutes to complete the questionnaire as you will be providing valuable information to assist future level bust prevention work.