HindSight10

The ability or opportunity to understand and judge an event or experience after it has occured

EUROCONTROL

Level Bust... or Altitude Deviation?

Level Busts: cause or consequence?
by Professor Sidney Decker

The 'Other' Level Busts
by Philip Marien

Air Traffic Controllers do it too!
by Loukia Loukopoulos

Winter 2010

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CONTACT US

The success of this publication depends very much on you. We need to know what you think of HindSight.

Do you find the contents interesting or boring?
Are the incident descriptions easy to follow or hard to understand?
Did they make you think about something you hadn't thought of before?
Are you looking forward to the next edition?
Are there some improvements you would like to see in its content or layout?

Please tell us what you think – and even more important, please share your difficult experiences with us!

We hope that you will join us in making this publication a success. Please send your message – rude or polite – to:
tzvetomir.blajev@eurocontrol.int

Or to the postal address:
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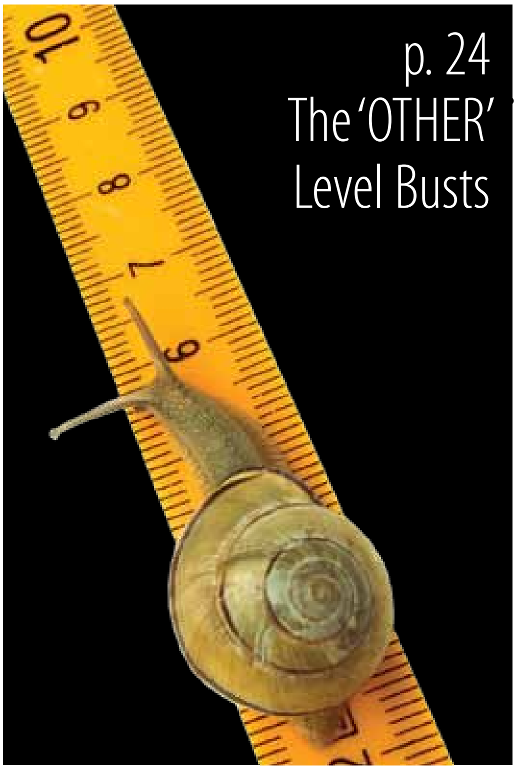
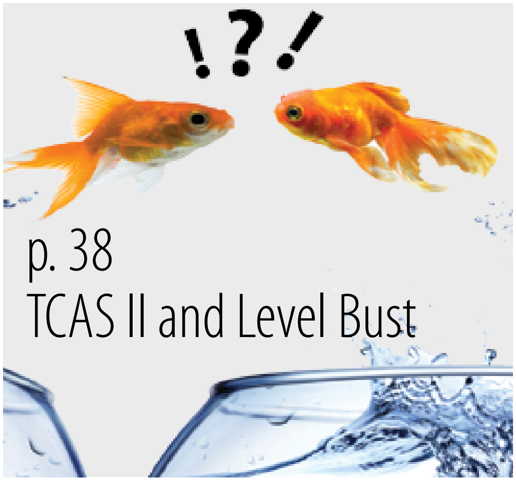
B-1130 Brussels

Messages will not be published in HindSight or communicated to others without your permission.





Hindsight receives a prestigious award!

Tzvetomir Blajev, Editor in Chief of Hindsight - Fellow of the Flight Safety Foundation and Bill Voss, President and CEO of the Flight Safety Foundation

I am very happy to tell you that HindSight has this year received an award for the best aviation safety publication – the Cecil Brownlow Publication Award.

This award was first presented in 1968 as the Flight Safety Foundation Publication Award and was renamed in 1988 in memory of Cecil A. Brownlow, an aviation journalist and a former FSF editor. It is awarded in recognition of significant contributions to aviation safety awareness. Recipients may be individuals, publications or organisations and are presented the award in recognition of consistent achievement or outstanding articles, books or works in electronic media which have been published or broadcast over a 12-month period.

For 2009 the award goes to HindSight as a magazine. But our magazine is a true collaboration between many people…dozens of authors, hundreds of experts giving feedback and suggestions and, most of all, thousands of readers.

You are all part of this magazine and the Award goes to you!

So I would like, on your behalf, to thank the Flight Safety Foundation for honouring us.

And especially at this time, there is a special place in this Editorial, a special place in the history of HindSight and a special place in my heart for the person who first made HindSight possible – Ian Wigmore. It was the beginning of 2004 and I had been working for just two years as Chairman of the EUROCONTROL Safety Improvement Sub-Group (SISG), where I had been tasked with fostering the "Safety Information Sharing and Safety Improvement". Various products emerged from this work – EUROCONTROL safety alerts, safety action plans and toolkits and, a little later, SKYbrary.

It was also proposed by the SISG that we should look for a way to regularly publish the accumulated knowledge in an easy-to-grasp style and language. I had been making several attempts to "prototype" such a publication, but it did not feel like we were getting anywhere. Then I talked to Ian, who was helping me with the Level Bust Toolkit at the time, and he said "I know what you mean - just give me the material and let me give it a try". Ian "cooked up" the formula for HindSight and remained behind the scenes to help out for several years, working on the preparation of every issue until Number 8, when he decided it was the right time to 'retire' and spend more time at home with his family, where he now enjoys reading HindSight!

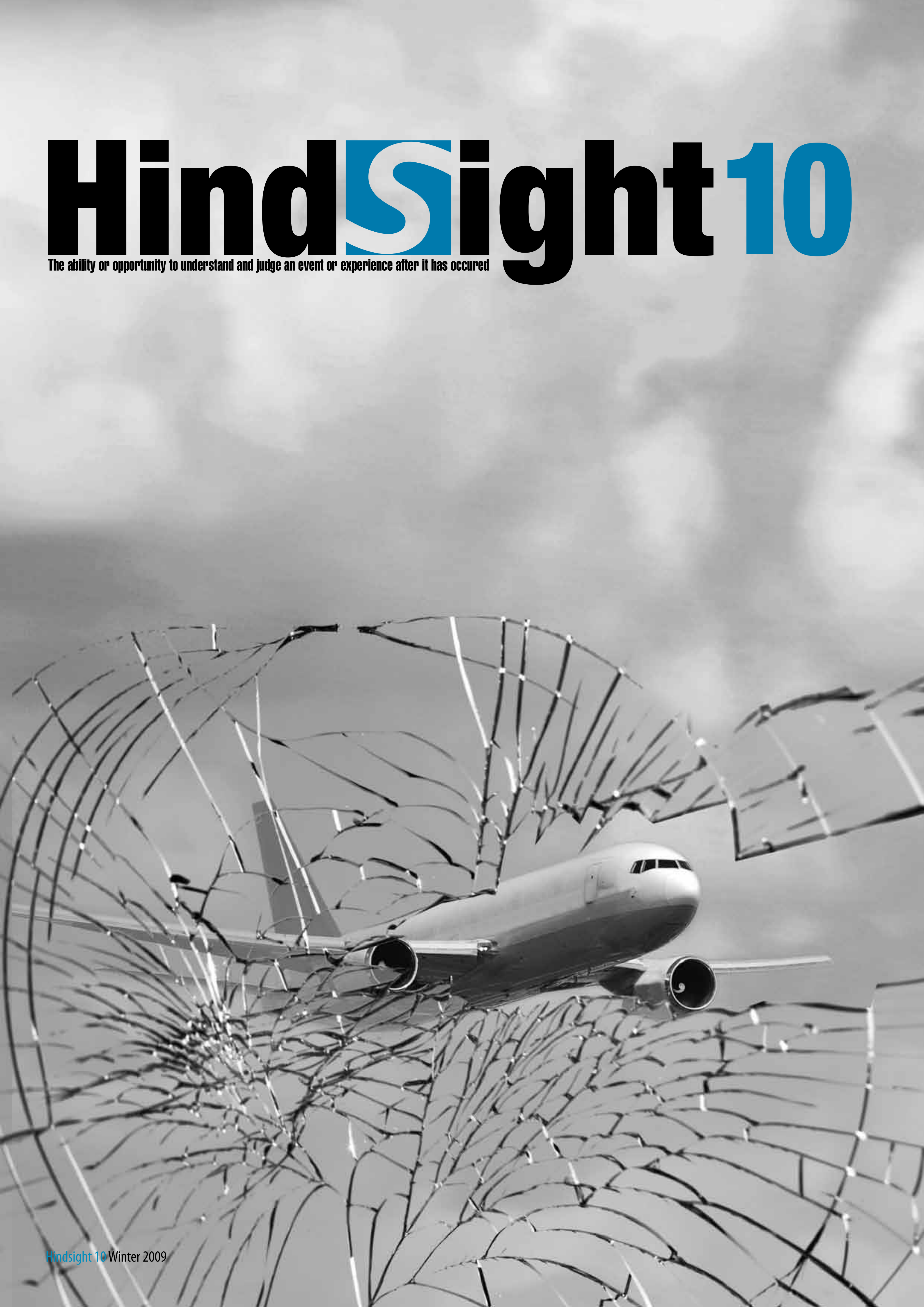
You are all part of this magazine and the Award goes to you!

In this issue you will read about level bust. You will see the level bust question from various angles. Is this really the issue to concentrate on? Is level bust only a concern for airlines since, by definition, it is the result of "pilot error"? Can ATC help to reduce the risk? What is the link between level bust and controlled flight into terrain? Can a TCAS RA response lead a pilot to bust his/her cleared level? What is our understanding of TCAS in this context? What are our options for issuing avoiding action if a level bust looks like it will lead to a loss of separation? Do we overestimate our ability to do more than one thing at a time? And how can new technologies like Mode 'S' help to reduce the level bust risk?

Enjoy the reading!

HindSight 10

The ability or opportunity to understand and judge an event or experience after it has occured



Front Line Report: All is well at Schiphol

If I had a list of safety issues over which I might lose sleep I don't think that "Level Busts" would be on that list. I can't provide a specific reason for this, it just doesn't seem to be a major issue in my working environment. Put more precisely, aircraft not adhering to their assigned altitude have not caused any seriously dangerous situations in our airspace without the issue being resolved in a timely manner one way or another. I guess that makes us good "undesired state" managers at Schiphol. Well, either that or we've just been lucky so far.

By Bert Ruitenberg

Compared to other ATC environments we perhaps apply vertical separation less often as a means of separating aircraft pairs. Don't get me wrong, vertical separation is used constantly for all departing and arriving aircraft but usually only to establish a temporary buffer in case something unexpected happens. This buffer may exist for only a few seconds or for a couple of minutes; normally before the aircraft reach the assigned altitude/level they get a clearance to continue their climb or descent to another altitude/level. Our main working method therefore is to apply radar-based horizontal or lateral separation between climbing and descending aircraft in most cases.

After EUROCONTROL released its Level Bust Tool Kit a few years ago, we went back to our incident records to see if we had been missing anything with respect to detecting a trend in events. The records however confirmed what I mentioned at the beginning of this article: yes, over the years there had been a couple of "Level Bust" events in our airspace, but none with serious outcomes. The fact that an aircraft didn't level off as expected was detected either by a controller (by observing the Mode C readout on his/her screen) or by the TCAS of the aircraft involved.

And in those cases where TCAS helped resolve the issue, it often appeared that the intruding aircraft was in fact levelling off neatly at the assigned level – but sadly with an incorrect pressure setting at its altimeter. This means there was little vertical movement between the aircraft even though the required separation was less than 1000 feet (which triggered the TCAS intervention) and consequently little chance of collision. Since such events mainly occurred in conditions with low QNH values (say less than 1000 hPa, i.e. the 3-digit values), a procedure was established to include a warning about low QNH in our ATIS messages, which seems to be reasonably effective.

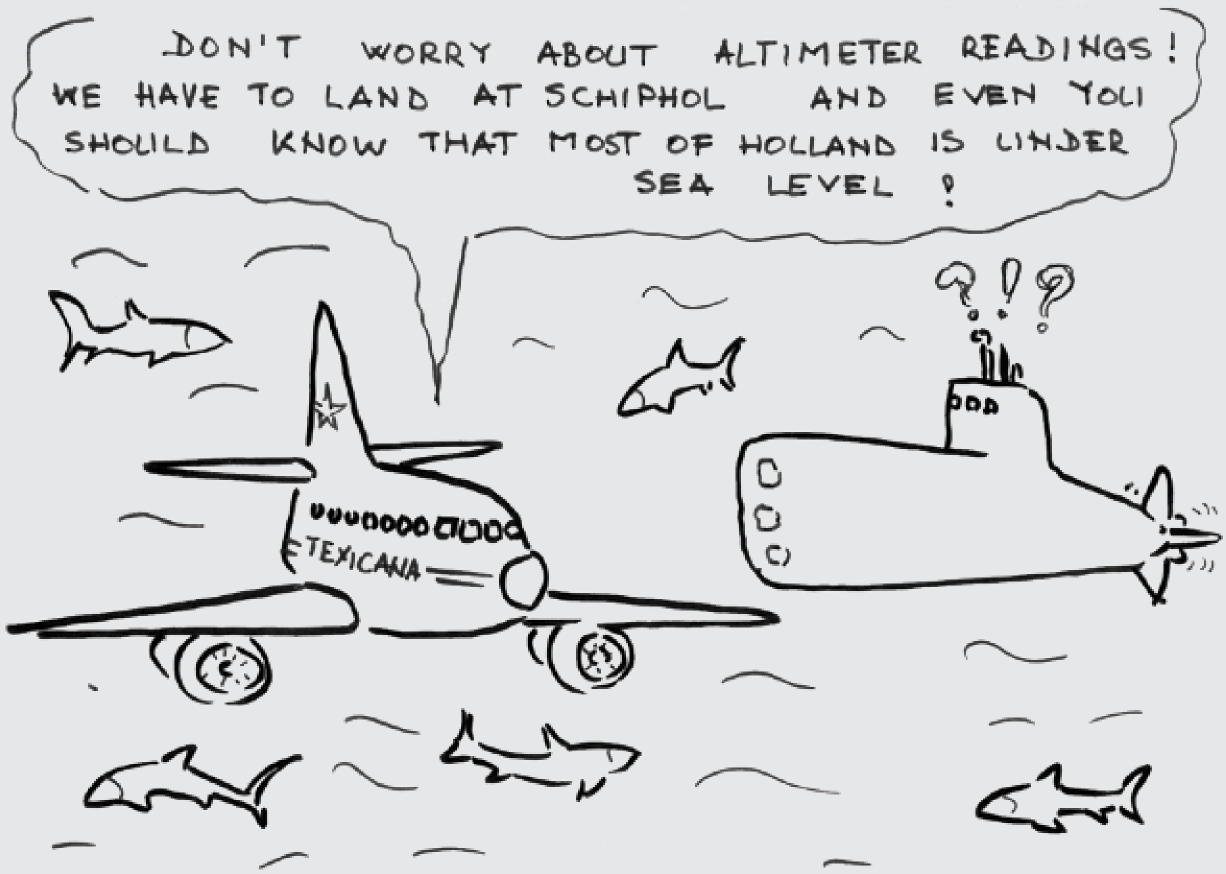
Another point is that historically we've had a significant amount of traffic originating from the US of A, the land with the interesting differences in aviation procedures compared to… well, the rest of the world basically. One of the differences that is relevant for the Level Bust issue is the unit used to indicate barometric pressure: where the rest of the world uses hectoPascals (or millibars, before the name change) the US of A uses "inches of mercury", with values that look like "29.90".

> Regulated traffic volumes and numbers per sector are not the same as safety

Bert Ruitenberg

is a TWR/APP controller, supervisor and ATC safety officer at Schiphol Airport, Amsterdam, The Netherlands.

He is the Human Factors Specialist for IFATCA and also a consultant to the ICAO Flight Safety and Human Factors Programme.



And since the Americans are only human beings like the rest of us, they informally often drop the first digit from the pressure value (since it's usually a 2 anyway) and also the decimal sign, so over the R/T a QNH of 29.92 would be referred to as "992". The potential for confusion when used or interpreted that way in an environment where the pressure unit is hPa will be obvious. And the potential for subsequent dangerous situations will be even more obvious when it is realised that a pressure of 29.92 inches equals that of 1013 hPa, which is quite a difference from 992 hPa – a difference of more than 500 ft altitude, to be exact.

But like I said, historically we've had a lot of experience working with pilots from the other side of the Atlantic so our controllers are aware of the issue outlined above. In the R/T they will emphasise the pressure unit whenever the QNH is in the 3-digit region, and they're keen to spot erroneous readbacks in those circumstances.

In summary, a fortunate combination of airspace design, equipment, procedures, training and controller experience (human factors) allows me to conclude that Level Busts are not a serious safety issue at Schiphol. The flip side of that coin is that if Level Busts are a serious safety issue in YOUR working environment, these are the areas where you may wish to start looking for improvements. The order in which I listed the areas is significant too: if you can improve in the ones mentioned first you're addressing the underlying problems more deeply than when improving in controller training and experience. And remember that one is not meant to exclude the other.

As air traffic controllers we pride ourselves in our skills, and our understanding of rules and procedures, that enable us to deliver the best of service to our clients.

Coming back to the title of this article, of course not all is well at Schiphol. We have our share of recurring safety issues generated by simultaneous operations on converging runways, and by routinely required runway crossings, and by environmental constraints dictating runway configuration changes, to mention only a few factors. Safety is a domain in which one never can go to rest without a certain nagging feeling somewhere in the back of one's mind that maybe not all is well – but that's not something worth losing sleep over. Or is it? ■

Level busts: cause or consequence?

If you have a level bust problem, you don't have a level bust problem. You have a level bust effect. **By Professor Sidney Dekker**

At a conference where I'd been invited to give a talk, the person speaking before me claimed that controlled flight into terrain, or CFIT, was the single most important cause of airliner accidents.

I bit my tongue, but had to wonder – the single most important cause of airliner accidents? I would have had no problem if the speaker had said that CFIT was the single most important kind of airliner accident, and that this kind of accident had many, many causes. But how could an eventual outcome, an airliner flying into rock or other kind of real estate, be the cause of an accident? Perhaps the workings of my brain aren't linear enough, but still, I could not bend my head around this one. A class of outcomes is the cause? Huh? How can an outcome cause itself?

David Hume, a Scottish philosopher who lived in the 18th century, had a thing or two to say about cause. We see cause, he said, when we associate constantly conjoined events. It is the mental act of association that is the basis for our concept of cause – not something in the natural world. In other words, Hume suggested that assigning "cause" is in a way an act of faith. You don't really know that one thing led to the other thing (and whether there were no other, perhaps more important influences). But the repeated conjunction of the events, and the fact that one comes just before the other, gives you good inductive reasons to believe that one "causes" the other.

In Hume's world, then, there is still a separation between cause and effect, that is, one thing is the result of the other – even if that relationship is more of a mental leap of faith than a fact out there in nature. This keeps the idea that "CFIT is the major cause of airliner accidents" equally strange.

The same thing, I believe, may be going on when we talk about level busts. Level busts, we could argue, are a major cause of separation infringements. Well, in a very narrow technical sense that could be true. And not so strange. Of course if you configure moving objects in Euclidean space where the Y-axis (the vertical one) is a dominating organisation principle (that is, you stack objects according to height), then, given the dynamics and uncertainties and unpredictability of complex interactions, you are going to get objects that sometimes do things along the Y-axis that are not entirely consistent with a controller's plans. You're going to get level busts, in other words. So the fact that level busts would be a cause of separation infringements, sure, I can buy.

But are level busts the cause of trouble? You see, if we stop there, then there is a very simple remedy, a classic remedy, in fact. All we need to do is ask pilots and controllers to try a little harder. Pilots, for example, should fight "complacency" when they are in familiar airspace, and pay a little closer attention when under higher workload in unfamiliar airspace. But are we then attacking the cause, or simply fighting symptoms, effects?

> "We see cause, when we associate constantly conjoined events. It is the mental act of association that is the basis for our concept of cause..."

Professor Sidney Dekker is Professor of Human Factors & Aviation Safety at Lund University in Sweden.

He gained his Ph.D in Cognitive Systems Engineering at the Ohio State University in the US.

His books include "The Field Guide to Human Error Investigations" and "Ten Questions about Human Error". His latest book is "Just Culture: Balancing Safety and Accountability".

He flies as a First Officer on B737NG.

Putting together a level bust working group or level bust taskforce is like putting together a headache working group or task force, whose job it is to reduce headache (the comparison may be apt in more ways than one). But fighting headache is fighting a symptom, an effect, of deeper trouble. This deeper trouble could consist of anything ranging from sleep deficit and fatigue to dehydration to cortical spreading depression (a neurological phenomenon associated with migraine) to vascular problems to a brain tumour. Fighting the symptom is not going to reveal the "cause" and is not likely to do anything meaningful about that cause.

We must ask the same question of level busts. The articles in this issue of HindSight reveal a wondrous panoply of underlying sources of trouble. Amendments to ICAO Doc 4444, PANS-ATM that are not uniformly implemented, growing mismatches between procedure and phraseology, cockpit design and automation ergonomics issues, psychological phenomena such as mishearing, misremembering, eye-hand mis-coordination in dialling an altitude in the window on the mode control panel, ATC display design issues like overlapping labels, overarching ATM policy reform such as reduced vertical separation minima, as well as social and physiological issues that include controller shift planning, diurnal de-synchronisation and fatigue, workload, organisational distractions, and more. Now the question is how "deep" you want to go, or believe you should go when digging for these sources of trouble. It would be nice to be able to say that these problems lie "at the root" of level busts, but of course, those problems themselves (e.g. not accepting an ICAO standard but publishing an exception in one's AIP) are again the effects of other problems and decisions and priorities and policies too. You tackle what you think you can change, and, if you want to, you call that the "root" of the problem.

In biology and genetics, scientists distinguish what is called a genotype from phenotype. Erik Hollnagel has applied the same distinction to our understanding of human error. The genotype is literally the genetic constitution of an organism: what is it made up of. In the case of level busts, you can see that they are made up of a whole variety of underlying things, from ergonomic to social to physiological to psychological — and located throughout the distributed system performing controlling work. The genotype, in other words, can vary a lot. The phenotype, that is, the observable expression of the problem, is the level bust, and the possible resulting separation infringement. That phenotypes look like one another doesn't mean much for the genotype. So when you have a level bust problem, you most likely don't have a level bust problem. You have a level bust effect. Look elsewhere for the problem and its sources. The level bust is just the expression, the observable effect of a whole possible host of other problems, the phenotype. If you tackle the result or the outcome, while thinking it is the problem, you may end up chasing the wind, pitching at windmills.

Editorial Comment

Professor Dekker's analogy between an initiative to solve level busts and one to 'solve' headaches seems especially apt! As he points out, there is clearly a limit to how far seeking to isolate the 'root' behavioural cause for a level bust is going to lead to effective action to reduce the chances of repetition. Perhaps, if we want to reduce the prevalence of level busts, we could more usefully focus on the full **context** in which they occur. What **exactly** did happen? However, do we actually know enough about that? Many who work towards fixing this problem do so using incomplete factual data and so have difficulty achieving a sustained human performance improvement which will produce 'results'. In which case we will not be able to determine interventions which might bridge the gap between the 'genotype' and the 'phenotype' which Professor Dekker identifies……

One way... for a pilot to (nearly) bust a level

The Prelude

Two management pilots, one of whom was in need of a line check, decided that a sudden decision by company operations to exchange an aircraft at the airport where they worked with another one at a different airport only 80 miles away provided a perfect opportunity to carry out that check. Both large jet aircraft would be empty and two jobs would be completed for the price of one – and in double quick time too – to everyone's benefit! Of course it would all be a bit of a rush compared to the usual two to three-hour trip east or south but that'd be no problem – and anyway any excuse to get away from the office was worth taking advantage of! The only recorded defect on the outbound aircraft was the TCAS…..

The Captain who had been called in to fly the detail was stood down and our intrepid duo joined the Co-Pilot at crew briefing! He was advised that the Check would be conducted from one of the SNY crew seats, with the Captain who was being checked designated as aircraft commander and that the Co-Pilot would not be under check. There would be an aircraft change after the first flight and the Check on the Captain would be conducted with him operating as 'Pilot Monitoring' (PM) on the outbound sector and as Pilot Flying (PF) on the return sector.

The Error and its detection

Just over half way through the first 25-minute flight, the Captain, as PM, began a call on COM 2 to the destination handling agent. At FL 140, there was plenty of time to get this call in before the company requirement to be back on COM 1 by FL 100. Unfortunately, the call took a lot longer than expected and he was not back on frequency until FL 80, by which time things were getting busy. He could see that continuous descent had been achieved and that the pre-selected altitude was below the current one, but there was no time for a formal de-brief on ATC exchanges which had taken place in his absence. This was unfortunate, because a few minutes later, ATC issued a

> Two management pilots, one of whom was in need of a line check, decided that a sudden decision by company operations to exchange an aircraft at the airport where they worked with another one at a different airport only 80 miles away provided a perfect opportunity to carry out that check.

new cleared altitude which was higher than the one already set - although it was still fortuitously below the passing altitude. And so the mis-set level was 'discovered'.

The Risk

Probably not much actual risk of CFIT – there was quite a high cloud base that day and the environment was generally familiar to all the pilots involved. But on a different day with neither of these favourable factors present and an airport known not to have MSAW?

A loss of separation risk? It was later confirmed that there hadn't actually been one. But with TCAS as an allowable (short-term) defect, the trusted safety net was not available and all the pilots knew that ATC covering intermediate approach at the destination had been having so many false alarms with their STCA that its alerts rarely induced a rapid response at busy times.

The Opportunity

First of all, if the Captain had either broken off or not made the handling agent call there would have been time for the required formal debrief and both pilots would also have been listening to ATC instructions by the time it became busy.

Secondly, in this particular case, the Captain was aware of the general terrain around the destination airport but since he did not remember the exact MSA and there hadn't been much time to dwell on the 'obvious' in the approach brief, he didn't immediately recognise the selected altitude as being below MSA.

Thirdly, it appears that the Check Captain wasn't paying much attention! The question of exactly what is the role of additional type-rated pilots who occupy supernumerary flight deck seats is an interesting one which goes well beyond this Line Check scenario.

Could ATC have helped correct the error? Well, since this was before the days of Mode 'S', and since the error by the Co-Pilot consisted of reading back the correct ATC descent clearance and then setting a different one then no, there was nothing they could have been expected to do prior to the pilots realising their mistake themselves.

The Consequences

- Flight Crew Embarrassment all round
- One failed Line Check
- One Check Captain admonished by the Training Manager
- One Air Safety Report completed...

Is this scenario common?

Well of course in detail obviously not, but taking the main message about 'who's listening', it does serve to remind all in air traffic control that, although there are two pilots on every flight deck, they are not always on the main radio frequency. There are company / handling agent calls, listening to the ATIS, communicating by intercom with the cabin crew and passenger address. All of this means that there will sometimes be only one pilot listening to ATC calls. Whilst an ATCO might reasonably say that they are in that situation almost all the time, for pilots, the division of labour between the 'Pilot Flying' and the 'Pilot Monitoring' is an important part of flight deck management. There is not too much of a problem when workload in the flight deck is low, but when things are busy….

The Solution

Preventive Action – Operator SOPs which require each pilot to listen to only one radio or intercom channel at a time and which also prohibit either pilot from leaving the main ATC frequency below 10,000 feet altitude except after a missed approach where a passenger address or cabin crew communications may be necessary if the aircraft is going to remain at low altitude, for which case a specific exceptional procedure must be provided.

Corrective Action – Operator SOPs which require that whenever one pilot intends to leave the frequency, they must ensure that their colleague is aware of this and when they return to the frequency, they must have an explicit debrief on the ATC communications which they have missed.

However, it's also true that all pilots, however experienced they are on aircraft type and however familiar they are with the operating environment, should realise that complacency must not prevail….at any time.

What can ATC learn from this?

Perhaps that 'local' flight crew are just as likely to be involved in a level bust due to underlying complacency as are 'visiting' flight crew due to higher workload. ■

Since the last edition of HindSight, two Safety Warning Messages and two 'Request for Support Messages' have been issued. Here we reproduce the two Safety Warning Messages and invite you to visit SKYbrary at:

www.skybrary.aero/index.php Portal:EUROCONTROL_Safety_ Alerts

to look at the two Requests for Support. They were about changes to ILS Signal Protection Requirements and the difficulties caused by 'Sector over delivery'. In both cases, good feedback was received from both ANSP an AO correspondents and a summary of the feedback on each case can be found with that information.

SAFETY WARNING MESSAGE

Maritime kite flying incident

Synopsis

Published 17 September 2009

The EUROCONTROL Agency has been informed of an incident that happened on 15 September 2009 over the southern North Sea:

"The aircraft was descending and identified a large kite/skysail flying ahead of the vessel and at around 1000 ft (just below the clouds).

It was attached to the vessel and was in the flight path of the aircraft as it headed towards a nearby installation. The 'skysail' was extended on a long cable and was moving around the vessel in an erratic manner.

Further research has shown that this is one of the first in a line of 'experimental' vessels using 'skysails' to supplement the traditional propulsion units."

The photograph below is an illustrative example of a "skysail":

Your attention is required

- Aviation authorities are invited to review their kite flying legislation, rules, applicable constraints and required coordination.
- Aviation service providers are invited to note the subject and investigate the relevance in their operational environment.
- Aviation professionals are invited to share their knowledge and experience of the issue described. ■

Keeping your eyes open!

All EUROCONTROL Safety Alerts available on:
http://www.skybrary.aero/index.php/Portal:EUROCONTROL_Safety_Alerts

Subscribe to: tzvetomir.blajev@eurocontrol.int

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SAFETY WARNING MESSAGE

Misuse of lasers - illumination of aircraft and ATC towers

Published 18 June 2009

Background information

Concerns about the hazards to aviation caused by the use and misuse of lasers in navigable airspace (in particular for pilots during critical flight phases) date back to the 1990s. More recently, however, some air navigation service providers (ANSPs) have also reported that ATC towers (TWR)) have been illuminated by lasers.

Lasers can easily be obtained via the Internet, even those that are recommended for professional use only. The devices are not inherently dangerous; however, when misused they may cause optical discomfort/injury and thus could compromise aviation safety.

Impact on ATS operations

The physiological (visual) effects/hazards to pilots/ATC staff associated with laser illumination are: distraction; glare; temporary flash blindness; afterimage; and, possibly, eye injuries.

Laser illumination of ATC TWRs could compromise the provision of safe ATS on or in the vicinity of aerodromes. Airport operations could be disrupted/suspended if a laser illumination of an ATC TWR was prolonged and the source could not be eliminated.

Suggested solutions

There is no universal solution for preventing the misuse of lasers against either aircraft or ATC. Nevertheless, coordinated State interventions (CAA, ANSP, airlines, police and justice departments, etc.) may be able to reduce the threat by:

- Amending criminal statutes associated with interfering with flight operations.
- Restricting the sale or use of certain types of laser. The UK, Australia and, more recently, Sweden, have introduced legislation to restrict/prevent the purchase and carriage of Class IIIB/IV lasers (i.e. those with an output power exceeding 5 milliwatts) in public.
- Expanding and enforcing 'critical flight zones' and 'laser free zones' around airports - see EUROCONTROL SRC Doc 7 (listed under Additional Information below) for applicability by the UK CAA and FAA.
- Improving labelling on laser equipment on sale to the general public.
- Educating the public regarding the risks of lasers to aviation safety.

Pilot and controller good practices/Immediate actions

It is suggested that airlines and ANSPs have processes and procedures (good practices/immediate actions) in place for staff to follow in the event of laser illumination. Measures could include:

- Look away from the laser beam if possible. DO NOT try to find the light source by staring at the laser.
- Shield eyes and consider feasibility of lowering/raising 'sun blinds' to reduce the effects of the laser.
- Avoid rubbing the eyes to reduce the potential for corneal abrasion.
- Consider feasibility of turning up the cockpit/TWR lights to minimise any further illumination effects.
- Consider handing over the flying/control position to a non-exposed colleague.
- Pilots: Consider the option of a 'Go-Around'.
- Pilots: Advise ATC that an aircraft is being illuminated. Controllers: Warn aircraft in the vicinity that ATC is being illuminated.
- Controllers: Inform a supervisor who in turn can: decide on restricting traffic in/out of the aerodrome; inform the airport authorities; and inform the local police.
- Ensure the event is recorded and then correctly reported for further investigation.

Additional information

Attention is also drawn to the extensive research that has been conducted into the effects of laser illuminations on pilots, much of which has a direct read across for ATC staff:

EUROCONTROL SRC Doc 7 - "Outdoor Laser Operations in Navigable Airspace" February 2001.

UK CAP 736 - "Guide for the Operation of Lasers, Searchlights and Fireworks in United Kingdom Airspace" November 2008.

The International Laser Display Association (ILDA) website provides a wealth of information and associated links about lasers and aviation.

ILFAPA Medical Briefing Note February 2009, "The effects of Laser Illumination of Aircraft". International standards SAE Standard AS4970 and IEC 60825-1 are both purchasable via the Internet and provide technical guidance on lasers.

EUROCONTROL Focal Point - Mr Richard Lawrence richard.lawrence@eurocontrol.int ■

Case Study - 'Plain Jane'

By Bengt Collin, EUROCONTROL

The Controller

The drizzle made the train ride to the airport more depressing than normal. Everywhere grey concrete or old dilapidated brick buildings all, without exception, covered with meaningless tags. If this was art he was Marilyn Monroe.

He had seen her on television at eight o'clock the night before; the first thing that sprang to mind was there's a plain Jane if ever I saw one. She was dressed in an average grey dress, hair style from the 60s; she explained in a steady voice why these young boys (it was never girls) expressed themselves by tagging everything in their way. "It is graffiti" she explained and looked into the camera, they have the art inside them; we should accept and understand.

I bet you'd change your mind if they tagged your front door, he thought and looked out of the train window.

The "Airport Express" train stopped again. Express? He was late for his shift.

The Citation Pilot

"Have some more mussels for akfast", he told his co pilot d laughed; "you never know when you'll next get some food inside you". The hotel they were staying in was near the airport, which was what they normally did – it was convenient, and because there were sometimes sudden changes in destination and departure times, it was handy too. They had never stayed here before though, he was not even familiar with the hotel location. That goes for the airport procedures too, he thought, but what the heck, what could really go wrong? It was one of his last days before going on holiday; minor problems like that would not spoil his good mood. "Jolly good" he said to his co pilot, a small man with a white face and a shabby shirt who was still almost asleep "now try raw herring with whipped apricot cream".

Bengt Collin

works at EUROCONTROL HQ as an Senior Expert involved in operational ATC safety activities.

Bengt has a long background as Tower and Approach controller at Stockholm-Arlanda Airport, Sweden

The Project Manager

Why do air traffic controllers always believe they know everything? He was not a controller, but working in the airport organisation for many years, he knew all about how to organise documents and fill in templates. Ever since his best friend had promoted him to Project Manager for Level Bust, he had kept every single file where it should be; no audit process would be able to criticise him; his career was on track. But why didn't the controllers pay attention to his long-term ten-year plan for prevention of level bust, it was unbelievable how uninterested they were, just sitting there in their sloppy jeans and t-shirts, whereas he always had a jacket on and kept his hair neat and slicked down.

The Controller

He discreetly slid down onto the seat next to Linda, in his opinion the most beautiful brunette on the planet. She smiled. Being a few minutes late, he had missed the weather forecast, but had arrived in time for the presentation from the level bust project manager. He looked at the first slides, heard the voice and stopped listening, thinking instead about the level bust incident two years ago that had gone all the way to Court. The prosecutor had finally dropped the case but the damage was already done; the reports stopped coming in. Why have these presentations when the real problem is elsewhere? He looked at Linda, she knew he was looking, but looked straight ahead with a Mona Lisa expression on her face.

The Citation Pilot

The small general aviation terminal was well hidden behind some old warehouses. Even the taxi driver had problems finding the right location. Although they were not late, the passengers were waiting for them when they arrived. The co pilot rushed through the NOTAMS and started to fill in the flight plan (I need to tell him to wear a fresh shirt next time), while he introduced himself to the customers. After a few minutes the minibus arrived, he told his co pilot to hurry up. They climbed in the transport and said hello to the driver, who for the bargain price of 55€ drove them the 30 metres to the aircraft. He helped the passengers to settle down in the cabin and went through the safety instructions while the co pilot prepared the flight, trying to figure out how to fly the departure route.

The Project Manager

He was about to start his presentation when another controller arrived late. Disrespect! They were simply not interested, not understanding the risk associated with level bust. He should suggest that the deputy manager insist on a mandatory reading of the long-term plan; that would show the controllers what is important in life!

The Controller

His sector was not one of the busiest, but it was complex. Most of the traffic he handled was inbound to the large airport nearby, but the sector also included two other airports. One was very quiet, light VFR flights that almost never called on the frequency, but the traffic from the other airport could create conflicts with a consistent flow of inbound and outbound business jets. It was from time to time surprisingly busy, more than you would expect from an airport that far out from the city.

He received a call from the ground controller, another departure soon to be airborne. "We changed runway to runway XX", the ground controller told him, "the wind is increasing". "OK, then it is POPPI 2 Bravo Departure, flight level 120, transponder 7172 for ABCDE". The readback from the ground controller was correct.

The Citation Pilot

"Can we please do the 'before start check-list'" the co pilot, who was going to be 'Pilot Flying' for the sector, asked him. He started reading very quickly. Call the tower for start-up and clearance, he instructed the co pilot quietly but firmly as soon as they had finished the check-list down to the line. They received clearance including QNH 992, continued the check-list, started-up the engines, 'after start check-list' the co pilot called. We need to do the flight briefing, they have changed the runway for departure, the co pilot said; his voice was low, he did not like to be too pushy. The pilot asked for taxi instructions, started taxiing out, "Everything OK, we will soon be on our way" he said to the three passengers in the back, while checking they had their seatbelts fastened. They looked relaxed, one was reading a newspaper, the other two were looking at documents. Always busy, never relax, he thought as they approached the runway. "Should we do the flight briefing or are you prepared anyway", he asked the co pilot.

The Project Manager

He went through the door to the control centre and walked towards the watch supervisor. The supervisor, being busy discussing the roster with another controller, ignored him completely. "Can you make sure the controllers read through this important action plan" he said, interrupting the supervisor with a loud enough voice to arouse the interest of most of the controllers in the centre. The supervisor, not known for being a soft touch, looked at the project manager, waited a few seconds and surprisingly softly replied "Which rock did you crawl out from under, get out". The project manager was already half way towards the door; he hated controllers.

The Controller

Flight ABCDE was airborne, that was quick. He had a conflicting crossing aircraft maintaining FL 80, better be safe than sorry, he thought and re-cleared ABCDE to FL 70. Around him he noticed people turning around, looking towards the supervisor desk. Instinctively he also turned just in time to see the level bust project manager with a red face leaving the centre; that would probably keep him away for a week or two. The STCA alerted.

The Citation Pilot

They got airborne and he called the radar controller. "Re-cleared FL 70". He inserted the altitude in the FMS, the co pilot, the Pilot Flying, looked a bit uncertain. "Should we turn at DMW 3 or 5", he asked, it was different from different runways last time I was here. Last time, the pilot thought, I have never visited this airport before! He started looking at the plates for the answer. The altitude alerter sounded and the co-pilot started levelling out.

The Controller

He turned back towards his screen, the ABCDE aircraft had passed the cleared level 70, now FL74 and still climbing. "ABCDE descend immediately to flight level 70, crossing aircraft at your two o'clock position, 500 ft above". Nothing happened. Another aircraft called.

The Citation Pilot

We are at FL70 he said to himself with a puzzled look on his face. "Traffic, Traffic" the metallic sound from the TCAS filled the flight deck, what is going on? The co pilot began a slow descent, "look at the TCAS screen" he said and changed the altimeter setting to 1013; "set standard" he said, not expecting any reply from his colleague. The warning stopped. ■

Comment on 'Plain Jane' by Captain Ed Pooley

Well this time there's no equivocation about the 'root cause' of this loss of separation! Unfortunately, the relaxed, unprofessional, attitude displayed by the Citation Pilot is not particularly rare amongst professional air taxi aircrew who have been flying long enough to have achieved the status of aircraft command - and been in that role long enough to become comfortable in it, except (temporarily) as they qualify on a new aircraft type.

Captain Ed Pooley is an experienced airline pilot who for many years also held the post of Head of Safety for a large short haul airline operation.

He now works as an independent air safety adviser for a range of clients and is currently acting as Validation Manager for SKYbrary.

But before we look a little further at him, what about the other players? Was their behaviour in keeping with the professional standards which are expected of them? In any case, even if their approach was a little lacklustre, did it make any difference?

The Project Manager

A man with the wrong attitude! And given the absence of any prior background as a controller, a man not in the best position to achieve the confidence and respect of the people he needs to influence in order to meet his own performance targets….perhaps some time off the project on a course to belatedly learn how to 'win friends and influence people' would be a good move!

The Controller

Anyone who thinks of themselves, even privately, as so good at their job that they are invulnerable to error and believe that they will never miss an opportunity to fix problems created by others is certainly not very sensible and potentially is quite dangerous. A superiority complex is as dangerous in controllers as it is in flight crew…Perhaps it's time for an awayday at a mid-career group discussion about recognising, accepting and managing one's own performance limitations with a suitable - and credible - human factors expert in the coordinator's seat.

The Co pilot

It sounds like he may be doing the job because he's not likely to pass pilot selection for an airline and besides, he may lack that particular ambition anyway. Nevertheless, he almost certainly is doing the job because he likes flying – almost all professional pilots do! However, they can't all choose the job they'd really like and sometimes junior pilots - like this one - have to put up with Captains who don't feel any need to establish an effective flight deck team and give themselves the best chance of staying out of trouble. Sometimes, too, Captains like this one had a hard time themselves as juniors and still consider that being treated like an assistant rather than a fully functional colleague is normal. So whilst this co-pilot may not be the best available, he tries hard to stop the Captain generating the pre-conditions for an incident, but because of both his own weakness and especially because of the Captain's undue dominance - even disdain - he doesn't succeed. I'm sure that thinking about it afterwards, he wasn't surprised that they had failed to reset the altimeter sub-scale in time to avoid a 600 ft level bust. If at all possible, he should try and find a job with another operator!

The Citation Pilot

As we've already noted, there's no concept of a two-pilot team here! Since this Pilot probably didn't need to have a co pilot on these trips in the past, whereas now it's mandatory, it may well have led him to take the view that, whilst it's handy to have some help with all the boring bits in return for them being allowed to be 'Pilot Flying' occasionally, there's no need to treat him as a real contributor to the way the flight is conducted. He is still essentially a single pilot not the Pilot of a two man team. So, for this individual, there is seeming unawareness of 'Crew Resource Management' and a complete absence of any perception of where key risks are and the priorities which managing them must bring. Taken together, we have the perfect ingredients for an incident or worse, even in good weather and with a fully serviceable aircraft. It's worth this Pilot remembering that the absence of one or both of those could have 'woken him up' - or perhaps led to even more trouble en route than he actually caused. Even his belated recognition of an unfamiliar operating environment didn't trigger any useful response or interfere with his focus on 'after the flight'. It may already be too late in his career for him to recognise his poor attitude to the job on his own, so all will depend upon his employer. Enjoy the leave and perhaps there will be a call to talk things over with the Company Chief Pilot if the co pilot has decided to explain why he's leaving for a better job elsewhere.

The Unseen Culprits!

Without wanting to fall too far into the trap of conveniently blaming managers for all the failings of their employees, there are clear signs here that there are systemic failures at both the Citation Operator and at the ANSP. Both helped set the scene for this event and, no doubt, many more. Management creates the context for the way the people in their respective organisations function.

The ANSP
The management appears to have decided that they could enable the delivery of real progress in their level bust reduction campaign by appointing a manager for it who was unlikely to be suitable. Without prior controlling experience, he was always going to risk a credibility gap with the controllers, and add to that a personality seemingly unsuited to any interaction with people, the combination was really almost terminal. Promotions and appointments should never be predicated on who you know! Of course, some senior managers in many organisations prefer not to see the level below them as potential challengers for their jobs…This ANSP needs to carefully review their procedures for appointing managers internally to ensure they are selecting suitable people.

The Citation Operator
I think that it is unlikely that the poor operating 'style' of this particular pilot-in command was unique amongst all such pilots at the Operator. However, if it was, then for this particular Pilot either a period of successful re-education or an exit are the only options. In the more likely scenario of poor managerial oversight generally, the operator would need to consider the likelihood of safety achievement against long-term business survival. They either don't know that they have an ineffectively disciplined flight operation supported by an ineffective pilot training system, or they know this but have chosen not to act. I'm not sure which would be the worst since the result of either will eventually be very similar and would almost certainly be followed by business failure. I recommend that in either case, they allow an outside adviser to examine what is wrong and suggest a path to consistent and appropriate operating standards.

The Regulator
All aircraft operators are subject to regulatory oversight. I would have hoped that an Operations Inspector with operational safety at the top of their agenda would, despite being able to take only an overview of their 'charges', have not found it too difficult to detect a significant, and quite possibly a wholesale, deficiency in the way this Citation Operator was performing. In a properly run flight operation, there should have been no possibility of having even a maverick pilot-in-command on line. If, as I have suggested, it went rather deeper than that, then it should have been even easier to have identified failures in the way that pilots were selected and trained and in the existence and/or application of suitable SOPs and in how the Company communicated their expectations of operating philosophy throughout their business. I would certainly recommend a new Operations Inspector be assigned and, unless it can be shown that the previous one really was an exception, it may also be time for this Regulator to undertake a wider review of how to achieve effective operational safety oversight of air taxi operators generally.

THE MOST IMPORTANT RECOMMENDATION?

Well, out of the choice that I have offered, it has to be the one for the Citation Operator. They have failed, either on a one-off basis or, probably, more generally, to sustain an operating regime fit for purpose. So they need a careful look at their flight operations and flight training system, probably by an outside adviser, to find out where improvements are needed and then they need to act on it so that they manage their risk to a level their customers would expect. ■

Comment on 'Plain Jane' by Svetlana Bunjevac

This scenario is so rich with attitudes and situations! And it's so familiar too. Let me explain what I saw happening here.

Svetlana Bunjevac

teaches in EUROCONTROL Institute in Luxembourg. She is former controller, OJTI and shift supervisor.

The time pressure

In our business, time is of incredible importance. Both pilots and controllers may need to make their decisions in a split second. There you are, a straightforward statement which anyone can appreciate. Is that all? How about the time to prepare to do the job? If I do not give myself enough time to prepare for my shift, arriving "a minute late" after a great night out with friends, I find this is an additional burden we impose on ourselves. Whether pilots or controllers, we do not give ourselves a chance in such cases.

And in this specific case it meant, for the flight crew, no time to properly check out the NOTAMs, the airport layout or the SIDs. And at the very end of this case, time also becomes one of the reasons that the pilots do not change the pressure setting from QNH to QNE, thus causing their level bust…

Controller or Pilot experience

Experience cannot be bought, it is built over time and it can save lives. Again, another bold statement and nothing wrong with it. In this specific case we have a controller, a pilot and a co pilot who are all experienced professionals. And yet the controller stops listening after the first slides about the level bust project as he starts rolling the film of the level bust case he has in his mind. How much potentially useful new knowledge has he missed? On the other hand our experienced pilot has never been at this airport before but "what the heck, what could really go wrong?" I vote yes for experience that makes us reliable and attentive pilots and controllers. But how are we to remain reliable, attentive and experienced? That is the challenge…

Professional stereotypes

What is the difference between a god and a controller? A god does not believe he is a controller. Controllers resist change. Engineers are systematic, controllers are not. Project managers know how to run a project no matter what the nature of it is. Pilots may be team players – or they may be god. Co pilots may be able to be - and capable of being - part of a team - or just be along for the ride. We all know these "truths" and there are many possible results. In this case, our project manager is given a task that needs some understanding of controllers' and pilots' jobs. Unfortunately, he feels so antagonistic towards controllers that

it prevents him from learning about their job. What could be the effect of raised voices in the Ops Room? How should the briefing presentation on the level bust project be made so as to keep the controller's attention. And the controller's perception (implicitly) of our project manager – he doesn't have a clue about air traffic control, why should I listen to him? I can learn nothing from him. Strong statements, aren't they? Are they wrong? Does this happen back home in your Ops Room? Does this happen here, where we are now? If no, that's cool. If yes, what is the risk? I did not say I had the answers…

The way we communicate

"Should we do the flight briefing or are you prepared anyway?" the Pilot asked his co pilot. What would you answer if you were the co pilot in this case? Honestly? I do not know if I would risk being taken for a fool if I said "I'd like to do the flight briefing please, if possible." Especially if I was a young co pilot having the "honour" of flying with an experienced Pilot! The way the original question is asked, it implies that the correct answer is "I am prepared". The "should we do the … or…" type of question is perfect for a dinner out. But in this case, I would expect more of a "Let's start the flight briefing…" approach. That briefings are meant to be done – and done to good effect - is self-evident, don't you think?

RECOMMENDATION

Please always consider what effect you as a colleague have on others. Pilot on Co pilot, OJTI on Trainee, Engineer on Controller, Controller on Project Manager and vice versa for all. And of course what effect we all have on what ultimately happens. But let's start with small steps – how does what I do affect my immediate colleague? ■

Comment on 'Plain Jane' by Dragan Milanovski

An unfortunate level bust incident where the Citation pilot failed to adhere to the altimeter setting procedure of setting the standard pressure when passing the transition altitude.

Dragan Milanovski

is ATC training expert at the EUROCONTROL Institute of Air Navigation Services in Luxembourg.

Most of his operational experience comes from Skopje ACC where he worked for a number of years on different operational posts.
Now, his day-to-day work involves ATC training design as well as Initial Training delivery for Maastricht UAC.

To be fair, there were other contributing factors that individually might not have had any consequences, but in this situation played an important contributing role. We have a depressed controller, who has just taken over a complex sector, issued a relatively late re-clearance during a critical phase of flight. Additionally, he had been affected by his 'interaction' with the Project Manager and the Supervisor. And we have the co pilot, who did not want to be pushy and challenge the Pilot and his "happy-go-lucky" approach, passively contributing as well.

It is easy for us controllers to blame the pilots, and even easier (and done with pleasure!) to blame project managers of this sort. However, this will not help us avoid or limit the effect of this kind of incident in the future.

But can this kind of incident be prevented in the future? Probably not….

The nature of business flying often involves operating to/from airports unfamiliar to the crew. The "produc-

Comment on 'Plain Jane'
Dragan Milanovski (cont'd)

tion pressure" from customers is high and usually, the crew is expected to organise additional tasks (hotels, taxi, flight plans, safety briefings, catering for the passengers and who knows what else), which significantly affects the overall impression of the service provided. All this is probably not going to change. The pilots are human (for now) and they make mistakes, especially when exposed to stress, when flying the aircraft is just one item on a list of many.

Can we learn something from this incident? – I think quite a lot.

No matter how experienced and confident a pilot you are, you must have respect for the aircraft you are flying. Cutting corners with procedures will not save you time or make you more efficient. Yes, customers have little understanding of all the procedures and the time it takes to execute them; but the last thing customers want to see is a careless attitude and safety consequences caused by it.

The co pilot has probably learnt his lesson. Next time, he will probably be pushier and challenge his Pilot if flights are not properly prepared or when briefings are skipped. Both of them can benefit a lot from this experience after analysing this incident and appreciating how it happened.

Controllers are well aware of altimeter setting procedures; however we tend to forget that our actions may contribute to associated level busts. Any late reclearance involving a level-off shortly after passing Transition Altitude when QNH is below standard may increase the chances of a level bust. Of course, such clearances cannot be completely avoided, but sometimes we have to use them and when we do, we need to exercise extra caution when separation is at stake.

The way the Project Manager was described in this story is somehow rather familiar to me. Unfortunately, I know quite a few that match his description. Having project managers who will "teach controllers what is important in life" is not new to aviation. Many projects have failed or have not achieved the expected results because of this approach. Antagonism between controllers and the rest of the staff does not help. We need to respect and understand each other better.

The controller from the story knew that an important link (or tool in the kit) for preventing level busts was missing, but did not offer his opinion. Even if he did, it would have probably been ignored by the Project Manager. Instead of trying to impose compulsory readings, the Project Manager has to find a way to get the controllers onboard his project. Involving them, even to the extent of effectively delegating project 'ownership' and certainly tapping into their collective experience effectively are examples of how to enable success in this sort of project. Controllers tend to listen more to other fellow controllers.

Antagonism between controllers and the rest of the staff does not help. We need to respect and understand each other better.

RECOMMENDATION

The ANSP involved here must take action to restore effective incident reporting as soon as possible. Long-term plans for prevention of level busts (although sometimes necessary) are a lot less effective than an awareness programme (as part of refresher training) based on a solid reporting system. Helping both pilots and controllers understand how and why level busts happen is probably the best way of preventing them. Should a level bust happen, this understanding is also essential for the provision of positive actions to re-establish safety. ■


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Comment on ‘Plain Jane’ by Alexander Krastev

This story is a “text book” example of how casual factors and circumstances can align in a sequence that puts aircraft and the lives of their occupants at serious risk.

Alexander Krastev

works at EUROCONTROL as an operational safety expert. He has more than 15 years’ experience as a licensed TWR/ACC controller and ATM expert. Alexander is the content manager of SKYbrary.

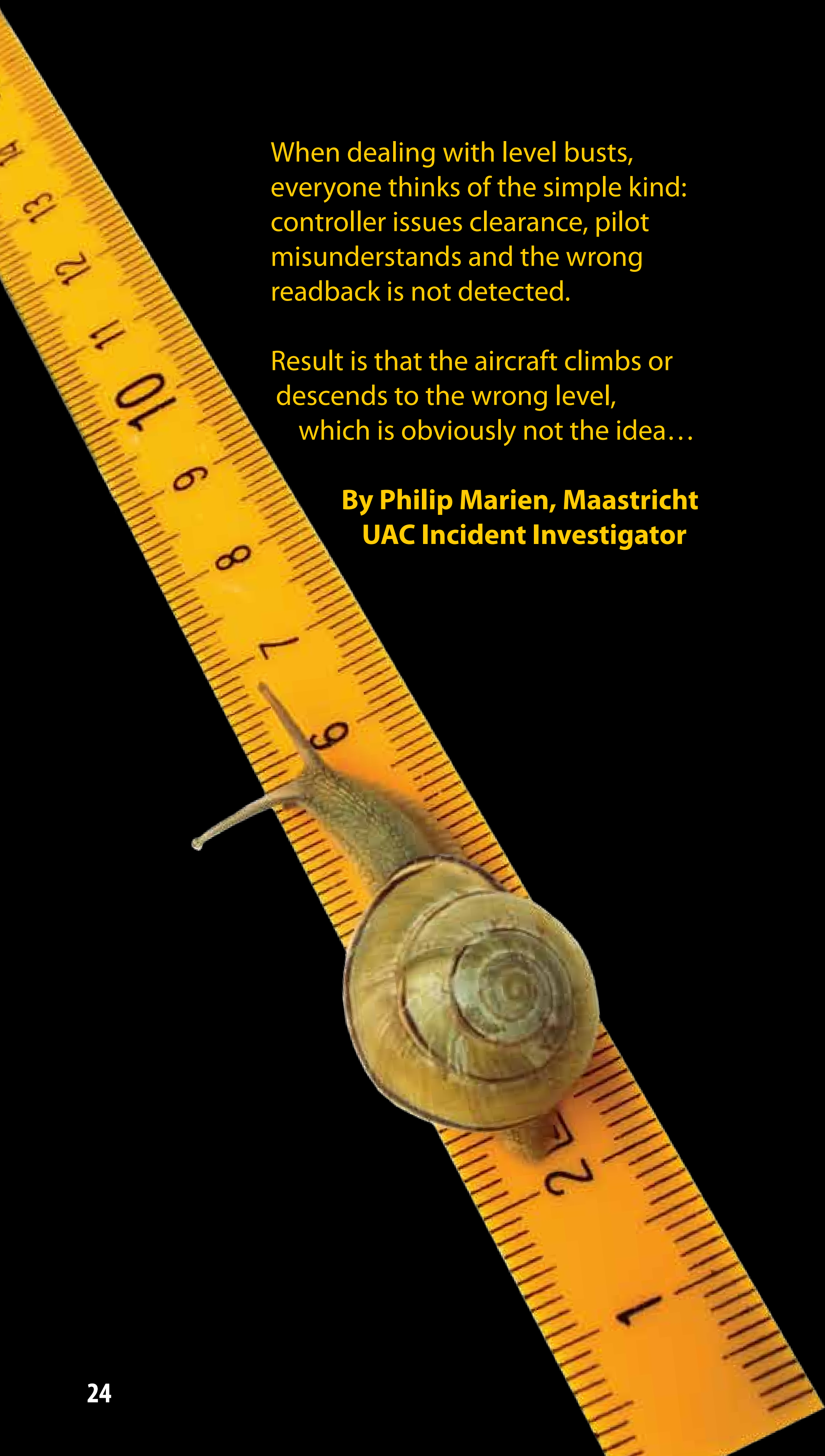
It started with the overconfidence of the Citation Pilot (“what could really go wrong?”), some may even describe his attitude as “negligence”. This attitude and the “press-on-itis” which is not uncommon for business aviation flights led to improper pre-flight preparation and a failure to re-brief following the runway change. Obviously the Pilot underestimated the effect on the crew’s ability to carry out their tasks with the required precision. The Co-Pilot, for his part, didn’t dare to challenge the authoritative behaviour of the Pilot. As a result, the increased workload, stress and confusion on the flight deck caused both pilots to miss changing the altimeter sub-scale setting at the appropriate time (the change from QNH to 1013 HPa) which eventually led to the level bust.

Why couldn’t ATC prevent it from happening? The easiest and most probably the wrong answer is that the controller lost concentration and turned away from the display to check what was happening at the supervisor’s desk. However, he could equally well have been busy dealing with another conflict preventing him from monitoring more closely the climb out of the business jet. In view of the sector complexity we are told about, a more proactive approach to risk mitigation is required, namely to prevent level busts from occurring rather than to rely on the quick reaction of controllers and pilots once it has happened. In this particular case this would have meant issuing conflict-free clearances to traffic departing from the secondary airport which restricted departures to lower levels, which would result in them passing below the main traffic flow. A common ATC practice is to resolve such issues by use of a dedicated flight level allocation procedure.

RECOMMENDATION

One could speculate that such a procedure was not in place because the risk of level bust had not been properly assessed. The reason behind this could be the impaired reporting seemingly consequent upon the absence of a just culture apparently evidenced by the controller’s concern about legal proceedings. ■

The 'OTHER' Level Busts



When dealing with level busts, everyone thinks of the simple kind: controller issues clearance, pilot misunderstands and the wrong readback is not detected.

Result is that the aircraft climbs or descends to the wrong level, which is obviously not the idea…

By Philip Marien, Maastricht UAC Incident Investigator

This type of event has been looked at from a lot of angles with some very clever solutions, including the latest one: to downlink the altitude selected in the onboard systems so the controller can compare it to his plan/clearance.

There are however more subtle cases of level busts. Perhaps these are not as dangerous as the classic level bust scenario, but they cause considerable stress and aggravation for a controller behind his radar. Not in the least because it usually involves having to fill in a form or two. In this article, I'd like to focus on those events.

Climb? YES WE CAN!

As airspace gets busier, controllers in some areas have become increasingly reliant on issuing vertical rate restrictions. Direct routes mean that it's not easy to give a geographical reference of where to be level. And the traffic density often means that a time or abeam restriction isn't precise enough to ensure separation.

Controllers will therefore often ask before the clearance whether an aircraft can climb with xxxx feet per minute. More often than not, the reply will be affirmative. Over the past years however, we've seen quite a number of infringements where the aircraft eventually wasn't able to comply with the agreed restriction. In the best cases, the pilot tells the controller in time to find some alternative solution (turns) but often, they'll simply not say anything until it's too late to avoid an infringement (see illustration 1).

In a lot of cases, the pilots seem at least as surprised as the controllers to see the aircraft reduce it's rate. It seems that predicting or knowing what the aircraft (i.e. the computers) will decide what is possible and what is not has become more difficult over the years.

Controllers are generally taught to use caution (read: build in extra margins) when issuing such instructions, but there's a limit to that. Understandably, the larger the vertical distance that needs to be covered, the more difficult it becomes to foresee the limitations on aircraft performance, both for pilots and controllers. Therefore, if there's any doubt whether the restriction can be met, controllers would prefer being told when the clearance is issued. And a reply like 'We'll try' in response to such a clearance is less than useless…

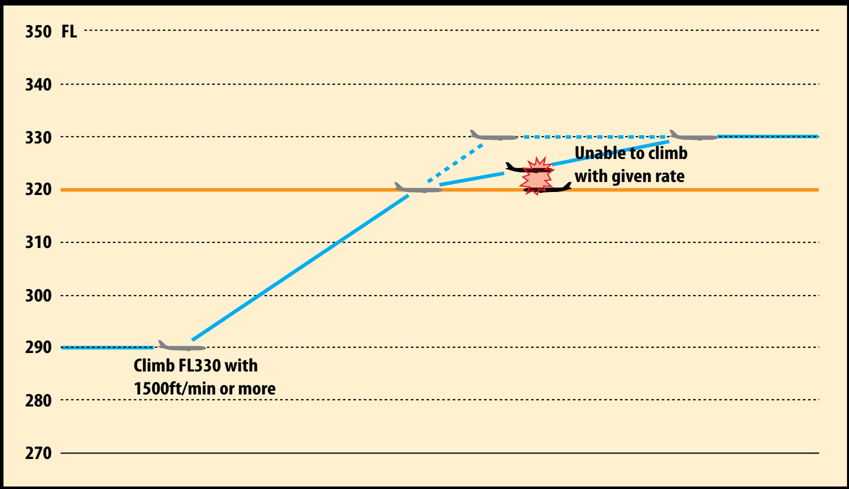


Illustration 1: instead of continuing at the agreed rate, the climbing aircraft reduces its rate. In the best cases, the pilot notifies the controller while an infringement can still be avoided.

Descent – Average or Absolute

Similar problem, except descent rates are usually less of a problem to maintain. The problem here comes from some airlines interpreting the requested descent rate as an average: they'll start descending slowly and cover the last few thousand feet with a very high rate. This may be problematic: quite often, the rate is needed for more than one reason. For example: an aircraft needs to be level somewhere to hand it off to the next unit, while there's also another aircraft between him and the exit level (see illustration 2).

While the absolute and average rates will both ensure the restriction will be met, only the absolute rate will ensure that vertical separation from the affected traffic (see illustration 2) will be enough to meet the restriction, it will not ensure vertical separation from the traffic in the middle…

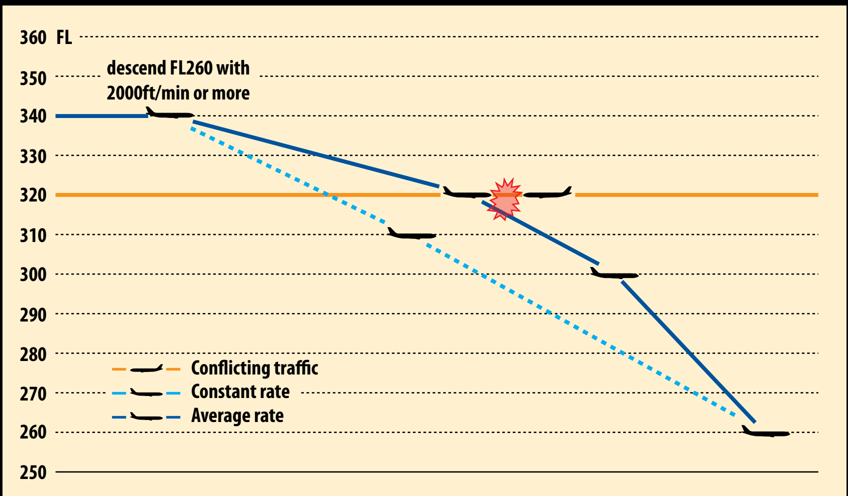


Illustration 2: the average vertical rate ensures that the aircraft is level at the intended point, but it meets traffic on the way.

> **Unfortunately, it's usually in busy and complex traffic situations that controllers have to rely mostly on the correct execution of the clearances they give.**

It may be possible in both these cases to issue traffic information to make the crew aware of what the problem is. Unfortunately, it's usually in busy and complex traffic situations that controllers have to rely mostly on the correct execution of the clearances they give. Quite often, there is simply no time to point out the full traffic picture to all pilots.

An additional problem with this type of profile is that the high rate at the end can easily cause TCAS Resolution Advisories – generally to adjust vertical speed. And those cause the next problem…

TCAS Bust

The last subtle form of level bust occurs when the crew 'forgets' their cleared level when following a TCAS resolution advisory. Typically, one or both crews get an RA that tells them to reduce their vertical rate when approaching their respective cleared levels. TCAS tells them to reduce the rate to 1000 or 500 ft/min a few hundred feet from their cleared level. The crews are trained to fly the RA accurately, and they ensure the Vertical Speed Indicator is in the 'green zone' calculated by the RA. However, the RA continues beyond the cleared level, as TCAS is completely unaware of the cleared level – otherwise it wouldn't need to trigger the RA. From a controller's point of view, the aircraft should level off correctly at the level they were cleared to (see illustration 3).

One can argue that the pilots should follow the RA, but from the controller's point of view, a perfectly controlled situation becomes quite stressful, as the aircraft end up with less than the required separation from each other. Agreed, if the RA is flown correctly they shouldn't hit, but why fix something that wasn't broken in the first place?

The upcoming (2011?) update of TCAS to version 7.1 will address this issue indirectly, by replacing the 'adjust v/s' RA with a simpler 'level off' instruction.

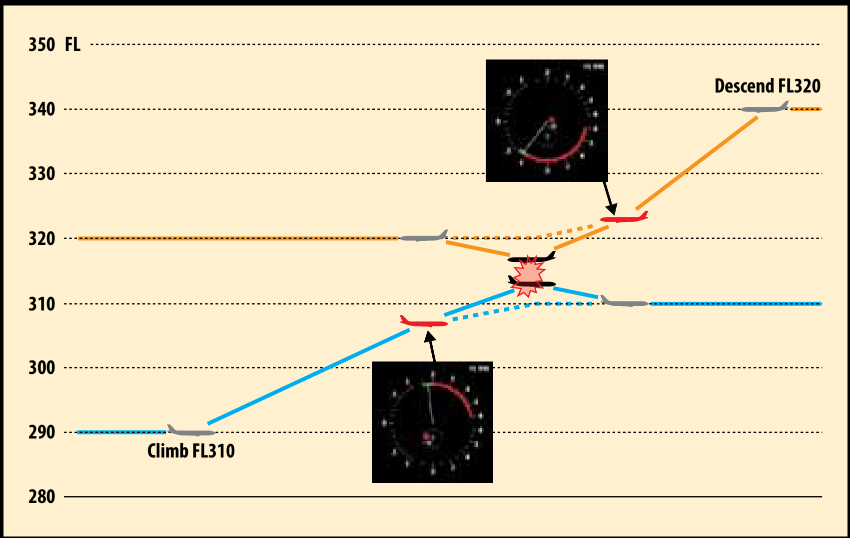
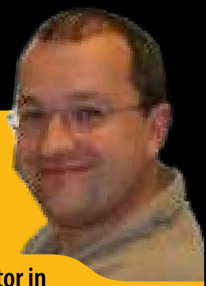


Illustration 3: approaching their cleared level, both aircraft get an 'adjust V/S' RA. Both put the VSI needlein the green zone, going beyond their cleared level.



Philip Marien
Incident investigator in maastricht UAC.

Distracting

While the risk to the aircraft involved in the cases outlined above is certainly less than in a traditional level bust, they can certainly cause problems indirectly as they increase the controller's workload significantly. They also regularly lead to animated discussions on the frequency and it wouldn't be the first time that another situation develops as a direct consequence of the controller being distracted by events like these.

Conclusion

Eliminating all and every type of level bust is unrealistic. While controllers need to realise that aircraft have performance limits, pilots need to be aware that they are not alone in the sky. Sometimes it's possible to give the reason for certain clearances and restrictions, but more often it is simply too time consuming. ■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Altitude Deviation or Level Bust What's in a name?

There are several problematic issues when exploring why these events happen. **By Anne Isaac, NATS, UK**

The first is often that organisations classify them as adverse event outcomes, rather than examining the many causal elements which should be considered as leading to these events; in other words a level bust or altitude deviation is the outcome of several adverse or erroneous activities, not the effect. How an organisation views these events may well dictate what is learnt and ultimately what mitigations are developed.

The second, rather more subtle issue concerns the world view adopted by the pilots and the controllers, since these are typically the only players in this 3 dimensional game. An ATCO's world view is based on a fast moving, dynamic sequence of multiple targets, all of which are important in their controlling strategy – it is for this reason that the majority take level bust events extremely seriously. The potential for several of their multiple targets being 300 feet from their assigned level is not only a risk, but increases their workload incrementally. In contrast a flight crew's world view is focussed on their own aircraft and its crew, passengers and cargo, effectively and safely arriving at the destination without straying into uncontrolled airspace and getting too close to buildings, high ground and other vehicles and aircraft. Therefore deviating by 300 feet from an assigned level is possibly considered just that – an altitude deviation, and if there was little chance of getting close to another aircraft, their perceived risk is low. Discussions with many airlines would reinforce that many of these deviations, although undesirable, are usually not high on the safety risk register. It is for this reason that we may have a rather larger problem to fix than the elements which lead to these undesired events.

Thus far it has been tempting, and often just plain practical, to try and tackle these events from either the pilot or controller's point of view; rarely do we seem to try and get a 'holistic' world view which takes into account the tasks and requirements of both professional groups. Clearly both groups are subject to similar human performance limitations and therefore it is not surprising that these events happen with predictable regularity. There have also been many learned reports and research papers detailing the causal factors of these events and lots of sound advice to help both ATCOs and pilots to avoid these situations. Many of these are familiar to us all:

- Altimeter setting errors
- Distractions – in the ops room or on the flight-deck
- Mishandling of the FMS
- Correct pilot readback followed by incorrect action
- An incorrect and unchallenged controller instruction
- An unchallenged incorrect pilot readback

The list is lengthy and typically partitions the responsibility to one or other professional group; so what could we learn if we took an approach which considered that these events were the result of simultaneous and consecutive error chains?

Some years ago, there was just such an opportunity to look at situations that were associated with this type of event from both sides of the radio/telephony, with the following results[1].

From an ATC perspective, incidents regarding level busts were associated with planning, coordination and communication. From the flight deck, errors that resulted in altitude deviations were associated with mis-handling, mode setting, communication and navigation.

Anne Isaac

leads the Human Performance development work in the pilot/controller interface in NATS, UK.
She gained her PhD in Cognitive Neuropsychology at Otago University in New Zealand. Her previous work has been in the development of incident investigation tools and techniques in European ATM, the introduction of TRM into the ATC environment and the introduction of Day to Day Safety Surveys techniques into NATS. She has written several book chapters, academic papers and the book Air Traffic Control: the human performance factors.

Both sets of errors were categorised at a high level as either a human information processing error (including decision-making, planning and execution), communication or an equipment malfunction.[2]

problems; risk acceptance (associated with assumptions), out of the loop (associated with situation awareness) and high stress levels (associated with workload and uncertainty). The nine situations can be listed as follows:

Error types	Flight-Deck errors	Ops. Room errors
Human Information Processing Error	14	66
Communication	5	24
Equipment Malfunction	1	1

Results indicated that the main problems for both professional groups were associated with information processing. For the ATCO it was in the monitoring and processing of clearances. For the pilots the issues were associated with executing a plan and flying that profile. In terms of communication, both groups demonstrated errors in the giving and receiving of clearances, and in monitoring compliance. The flight crews tended to have more robust cross checking built in to their SOPs, which possibly allowed these errors to be managed more effectively.

Having established the common error types, extensive further work was done by monitoring on the flight deck and in the ATC operational environment to establish the nature of simultaneous error leading to these level bust/altitude deviation events. It was established that both working environments could be degraded in nine ways which could lead to three

1- This research was undertaken in New Zealand
2- This categorisation was established in order to compare the flight-deck elements with the ATC elements and would not reflect today's more advanced approaches

- Risk acceptance due to (1) mutual confidence and underestimating risk;
- Out of the loop leading to or caused by (2) overload, (3) boredom, (4) preoccupation and (5) inexperience/ (6)over experience;
- Stress levels caused by (7) task overload, (8) unfamiliar situations and (9) surprise.

In this work it was also established that errors usually occurred during the first 15 minutes of an ATCO's shift and, in comparison, the majority of flight-deck errors occurred in the first AND last 15 minutes of the flight. This may be due to the differences in the distribution of workload, or in the way the flight-deck crews and controlling teams divide their tasks and responsibilities.

Typically, such research activity starts to explain the mutual reliance which one professional group has on the other and the need for them to better collaborate in lesson learning. It is clear that until each side of the R/T understands how the other views these events - as altitude deviations or as level busts - and what we can collectively do to reduce the risk, we may still be writing about the subject in another 15 years! I hope not, since it has been proved that for every level bust that is reported there are 40 'altitude deviations' which are not – so what is in a name?

Editorial Comment

Anne observes that the majority of flight deck errors found in the level bust research she quoted occurred in the first and last fifteen minutes of a flight and speculated as to why this might be so. We asked an experienced airline captain what they thought and there was no doubt – it was the combination of higher workload and the greater rate of vertical re-clearance which typically characterised both the initial climb and the intermediate and final approach. Our captain then went on to speculate in turn by suggesting that perhaps the prevalence of increased ATCO error rates during the first 15 minutes of their shift was a consequence of the higher workload that must typify the first sector takeover. He also agreed with Anne's point about the effect of the different focus of flight crew compared to controllers on the perceived 'importance' of level busts… ■

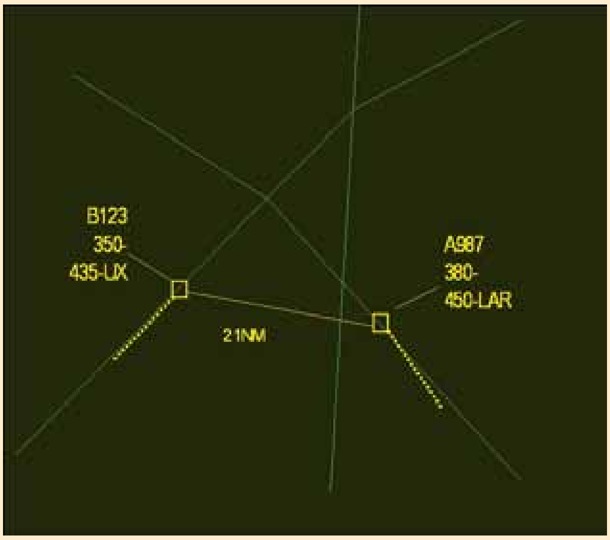
Level Bust avoiding action
Looking at the options

By Gilles Le Galo, EUROCONTROL

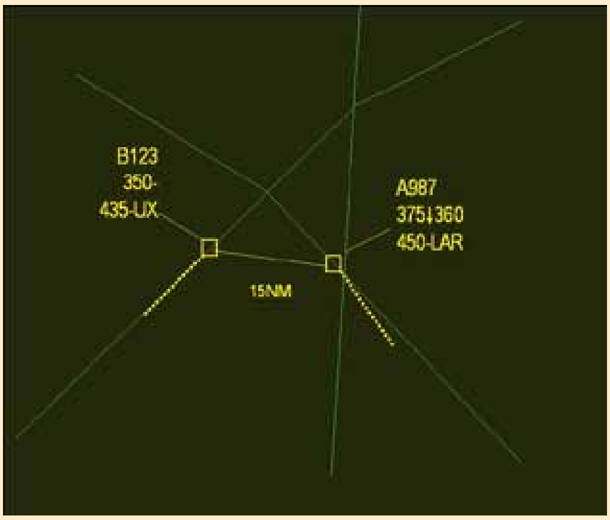
A SCENARIO

When things go wrong, they go wrong really fast...
Look at this level bust and its implications in 4 slides:

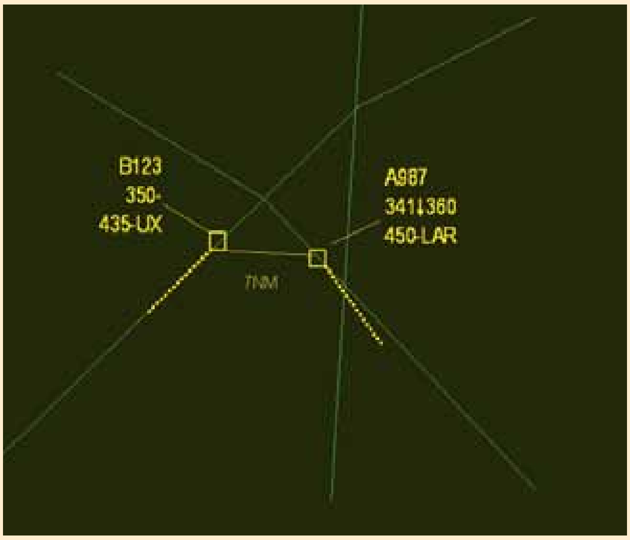
1. A987 needs to descend inbound to its destination. Because of the presence of B123 at FL 350, the controller decides to descend A987 initially to FL360, A987 is given this instruction and reads it back correctly



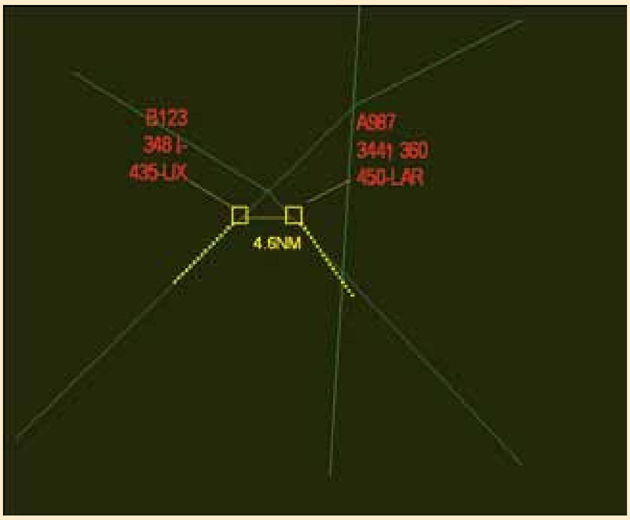
2. A987 starts the descent and the ATCO deals with other traffic



3. A987 actually descends to FL340 (due to an altitude restriction erroneously entered in its FMS) and does not tell the ATCO



4. NOW EVERYTHING GOES AT TOP SPEED!...



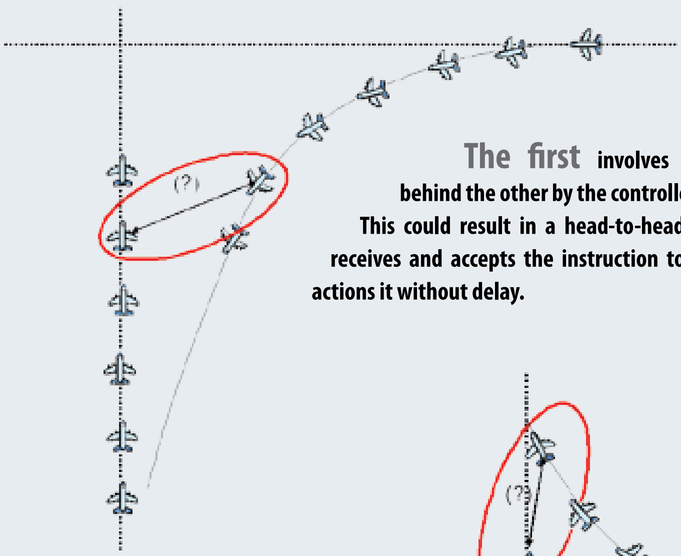
... and if everything GOES AT TOP SPEED:

- The controller realises that A987 has gone through its assigned level and clarifies with the pilot, who says he's climbing back to FL360
- The ATCO reclears A987 to descend to FL340 based on FL344 seen on the radar display
- A987 is in fact already well above FL344 due to the delay attributable to the radar refresh rate – if A987 were to have a climb rate of 3600fpm, this would produce a 300ft gain between display updating based on a typical 5-second radar refresh interval. For a 12-second radar refresh interval, the achieved climb would be 700 ft.
- B123 gets a TCAS RA to descend based on the proximity and projected path of A987 in the climb
- The STCA goes off
- A987, which is a business jet not equipped with TCAS, reverses its climb and begins to descend to Fl340 as instructed by the controller
- The two aircraft finally pass within 200ft vertically and 0.8NM laterally of each other.

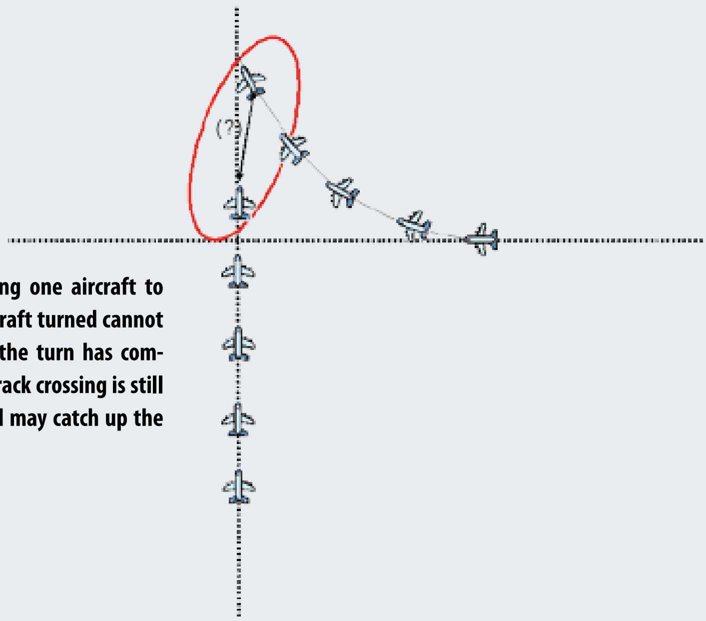
So, things can go wrong very quickly indeed! It's rather like the situation where you are sunbathing somewhere on a white sandy beach on a small Pacific Island with your girl/boyfriend and for a reason difficult to perceive at first a difficult subject comes up (maybe due to the Elizabeth Hurley/ George Clooney look-alike that just passed by!) and you really do not understand, and even less see, how you are going to get out of the situation in a safe manner.

SOME OPTIONS

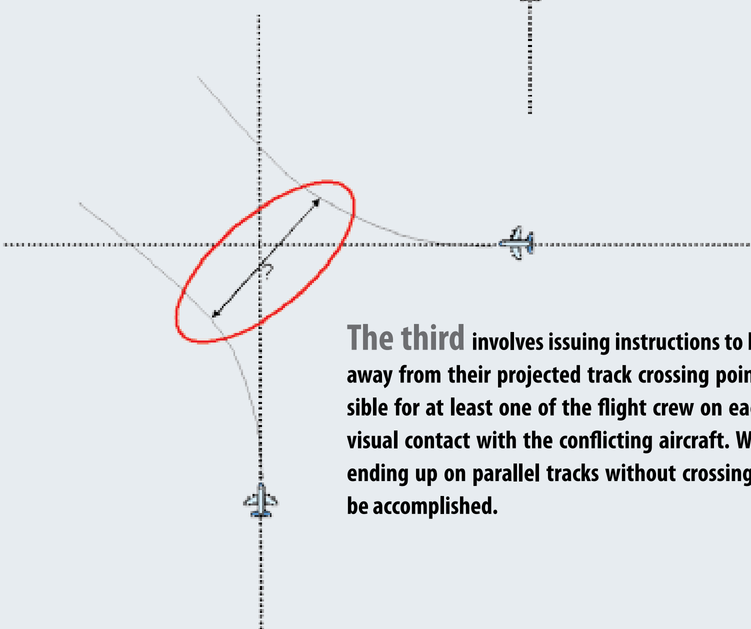
Should avoiding action be on a horizontal or a vertical plane? The ICAO procedure in PANS-ATM is unequivocal, it must be horizontal. Using radar vectors, a number of options are theoretically available for the case where two aircraft are approaching each other cross track. How efficient are they?



The first involves one aircraft being turned behind the other by the controller. The other is left on track. This could result in a head-to-head outcome unless the pilot receives and accepts the instruction to turn on the first call and actions it without delay.



The second involves turning one aircraft to pass ahead of the other. The aircraft turned cannot see the conflicting traffic once the turn has commenced and the completion of track crossing is still required. The aircraft not turned may catch up the one turned in front.



The third involves issuing instructions to both aircraft to turn away from their projected track crossing point. It should be possible for at least one of the flight crew on each aircraft to retain visual contact with the conflicting aircraft. With the two aircraft ending up on parallel tracks without crossing, that still needs to be accomplished.

Level Bust avoiding action
Looking at the options (cont'd)

A number of issues are common to all three options:

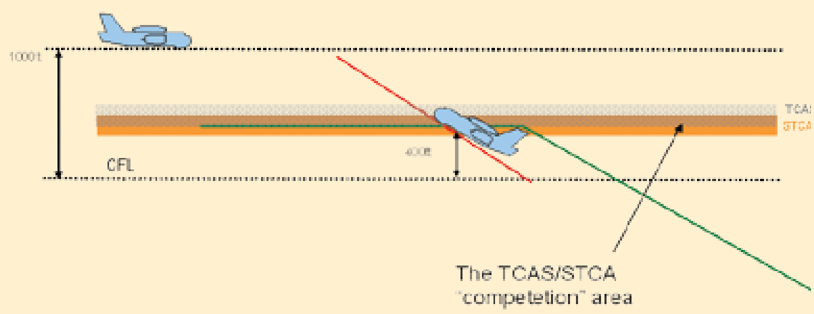
- The ground track actually achieved by any aircraft as a result of a turn will be predicated on the extent of delay before the instructed turn is commenced. This may be related to the extent to which the detail of the conflict scenario is grasped by the flight crew(s) involved either because this is effectively communicated by the controller or because of the TCAS display or both.

- The ground track achieved by the aircraft depends on the aircraft speed and the bank angle used during the turn. At a typical high level cruise speed of, say, 480 knots TAS, the radius of turn at a typical bank angle of 25 degrees would be over 7 NM.

- Of course, the wind is rarely calm at altitude! It can play an important role in restricting – or facilitating – the viability of particular solutions provided that it is not forgotten by the controller and can greatly influence the separation achieved. High-level conflicts caused by level busts can occur in jet stream conditions where wind speeds are a significant fraction of aircraft cruise speeds and may therefore have a significant influence on both the ground track achieved on a radar heading and on the ground speed which will result.

And if the turn(s) do not work for any reason, the only additional action available is a descent or a climb – there are no more horizontal options.

REAL TIME VERSUS HISTORY



As discussion of our example has shown, there is a discrepancy between what the controller sees and the actual position of the aircraft because of the finite radar refresh rate. This is often forgotten in a moment of high stress.

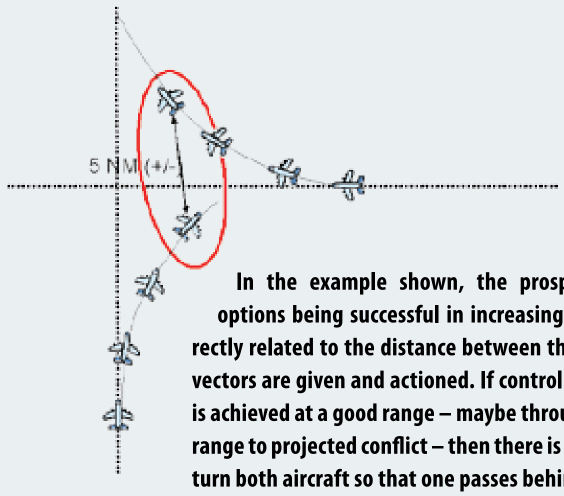
Another thing is that it is often perceived as easier for the pilot to make a descent than to climb whereas this is not necessarily an issue – although there may be a short-term effect on the resultant forward speed.

And there can be problems with the way STCA is activated. In our example, STCA did not help because in such situations it was inhibited by CFL (Cleared Flight Level) and by the relatively slow radar refresh rate - it was overtaken by TCAS.

And so to conclude, the only viable solution in our example at typical detection ranges was to let the A987 pilot climb (possibly asking him for the best rate) and give traffic information to both aircraft. Which is very easy to say but only training can prepare controllers for these issues. It's just like on that beach with crystal-clear waters, the way out is only easy if you thought in advance about the possibility of that subject coming up… ■

Gilles le Gallo
works at EUROCONTROL.
He has an extensive experience in operational Air Traffic Control, Safety Management System approaches, procedures and practices and Operational Safety improvements.

Postscript



In the example shown, the prospect of any of the turn options being successful in increasing the separation is also directly related to the distance between the two aircraft at the time vectors are given and actioned. If controller awareness of a conflict is achieved at a good range – maybe through STCA set at a 2-minute range to projected conflict – then there is a fourth option which is to turn both aircraft so that one passes behind the other.

Business Aviation and Level Busts

[This is an edited version of an article which was first published earlier this year in the magazine 'Focus on Commercial Aviation Flight Safety]

Business aviation, which accounts for about seven percent of flights in the United Kingdom, was responsible for almost 20 percent of the level busts recorded in that airspace, and five of the eight most serious losses of separation following a level bust.

By Peter Riley, NATS, UK

Between January and September 2008 in the airspace in which NATS, the U.K. air navigation service provider, provides the air traffic control (ATC) service, there were 356 incidents involving business jet aircraft. Fourteen of these incidents were within the higher risk category and involved a loss of separation, mainly due to level busts.

Responding to this trend, NATS has looked more closely at the specific issues posed by business aviation with regard to level busts.

As part of its efforts to reduce the number and severity of level bust events, the NATS Level Bust Workstream, a working group of representatives from across the company, has become increasingly concerned about the prominence of business aviation aircraft, in particular non-U.K. registered, non-commercial operators, in the statistics. Of concern are not only the numbers but the severity of the busts; business jets caused 5 of the 8 most serious losses of separation resulting from level busts in the 6-month period that ended in June 2008 (see Table 1 on next page).

The NATS Level Bust Workstream determined that the evidence of a problem is compelling. Going back to January 2007, the business aviation community accounted for 10 out of the 19 most serious level busts recorded, 52% of the number of serious bust events. Eight of those ten events involved non-U.K.-registered aircraft. Given this disproportionate involvement in the higher severity events, it is clear there was a need to focus effort on working in partnership with the business aviation community.

NATS believes that there are many reasons for the unwelcome prominence of corporate jets in the level bust event data. The nature of business flying is

Table 1: Serious Level Busts in NATS Airspace

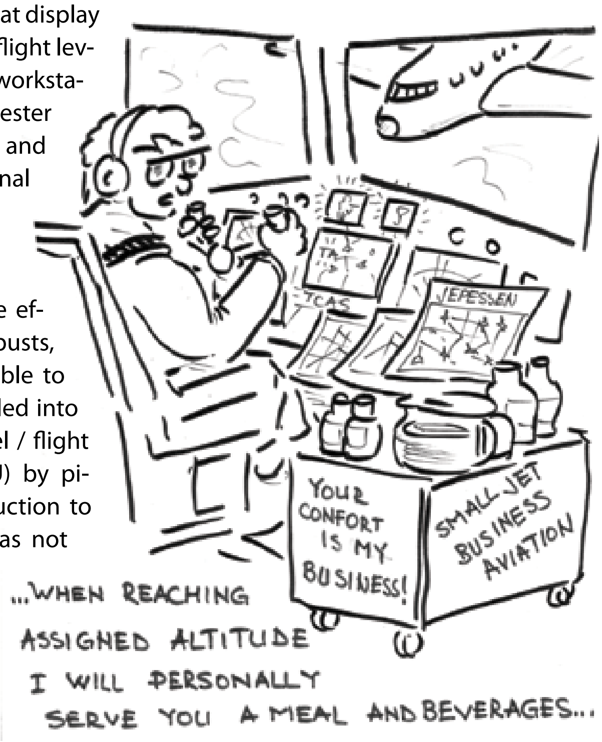
Date and Airspace	Summary	Primary Causal Factors
Jan. 14, 2008 Facon 10/100	The airplane descended below its cleared level and came into conflict with a Boeing 737-800, which was under the control of a different sector. Slow TCAS response was to "maintain passenger confort".	Incorrect TCAS response Rate of turn/climb/descent
March 7, 2008 Falcon 2000	The airplane was instructed to climb to FL 140 but climbed to FL 144 and into conflict with other traffic. The airplane had a very rate of climb and may have misinterpreted a TCAS RA.	Incorrect TCAS response Rate of turn/climb/descent
March 10, 2008 Falcon 50	The airplane was instruced to climb to FL 120. Approaching FL 110, it was given traffic information on an aircraft 1,000 ft above. The FA50 climbed to FL 127.	Incomplete readback by correct airplane Not heard
March 11, 2008 Falcon 50	On departure the airplane was instrucuted to climb to FL 80. The airplane was later observed at FL 87. The pilot was climbing on the QNH local pressure altimeter setting.	Altimeter setting error Not seen
April 1, 2008 Cessna 560	An inbound airplane was descended to FL 120. An outbound Cessna was climbed to FL 110. Both airplanes approached BPK at the same time. The Cessna was observed climbing to FL 117 before descending again. The inbound airplane received a TCAS RA.	Incorrect TCAS response Poor manual handling
April 11, 2008 Learjet 45	A learjet was instructed to climb to FL 80 against traffic descending to FL 90. The descending traffic reported a TCAS climb. The Learjet reported that it had also received a TCAS climb. It had climbed at 2,500 fpm with less than 1,000 ft to go.	Incorrect TCAS response Responded to TCAS/GPWS
May 26, 2008 Boeing 737-300	On climbout, the student pilot exceeded the cleared level by 600 ft before the training captain could intervene.	Correct readback, incorrect action Pilot under training
June 3, 2008 Boeing 737-800	Traffic in a holding pattern was cleared to descend to FL 70. The pilot's readback was garbled by another airplane's transmission. The clearance was not clarified by the controller and an incorrect airplane descended to FL 70, causing a loss of separation.	Pilot readback by incorrect airplane Not heard

such that crews often find themselves flying into airports and associated airspace for the first time. As infrequent visitors, a lack of familiarity with some of the more challenging procedures in U.K. airspace is probably a major factor. Among these challenging procedures are step-climb standard instrument departures (SID), a feature at many of the London region's outer airports, where business aircraft are frequent visitors.

There have been many instances recorded, and not only among the business aviation community, of crews "falling up the stairs" on a stepped profile. For business aviation, if the aircraft is flown by a single pilot, or if the crew is distracted from briefing the profile correctly - perhaps by having to perform functions carried out by other staff such as cabin crew on the airlines - the possibility of an incorrect or incomplete brief is increased. Throw into the mix the fact that many of the business aviation crews may not have the level of flight operations support available to airline crews, and the very high performance of the aircraft that are being flown, especially in the climb, and the reasons behind the prominence of corporate jet aircraft in the data become more obvious.

NATS has made great efforts to reduce the level bust threat, having introduced Mode S radars that display each aircraft's selected flight level (SFL) on the radar workstations within the Manchester Area Control Centre and in the London Terminal Control Operations Room at Swanwick Centre. Although this has had a very positive effect on reducing level busts, with controllers now able to see the flight level dialled into the mode control panel / flight control unit (MCP/FCU) by pilots following an instruction to climb or descend, it has not been the complete solution.

For example, the displayed SFL will not take into account any altimeter setting error made by the pilot. This is a common causal factor of level busts in the U.K., where the applicable transition altitude to change altimeter settings from local pressure readings (QNH) to 1013.2mb (29.92 inches) varies be-



Business Aviation and Level Busts (cont'd)

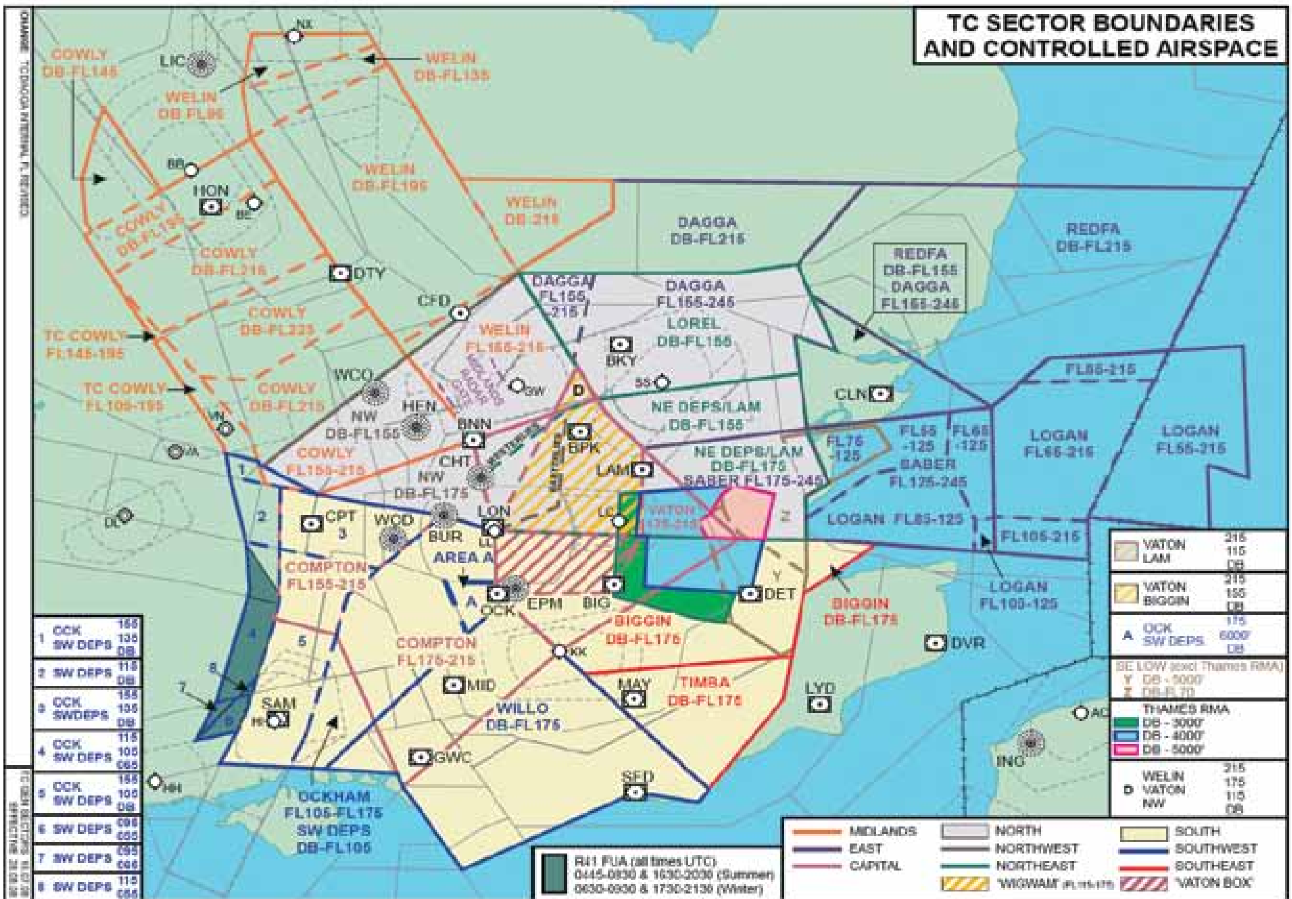
tween 3,000 ft and 6,000 ft according to the location.

It is appreciated that particular standard operating procedures (SOP) are chosen to enhance operational effectiveness according to the nature of the operation. However, where a pilot has programmed a step-climb profile into the flight management system (FMS), unless there is an additional SOP to set the profile restrictions in the MCP, there can be a disparity between the aircraft's SFL and the programmed SID, which can cause increased controller workload as they try to ascertain whether or not there is a level bust developing.

While there is little possibility that step-climb SIDs will be eliminated in the short term, avoidance of this procedure now is enshrined as a basic design principle for all future NATS airspace changes. In the interim, a number of successful mitigation measures have been applied at some NATS units; for example, providing with the departure clearance an explicit warning of the existence of a step-climb SID.

While helpful, Mode S SFL capabilities may create new hazards. Data is beginning to indicate a new issue. When the SFL displays the correct level to which an aircraft is cleared, controllers have a level of confidence in the crew's correct handling of the climb or descent that may turn out to be misplaced if the pilots do not adhere to sound airmanship principles of reducing the rate of climb or descent approaching the assigned level.

Further, a high rate of climb or descent can trigger a traffic alert and collision avoidance system (TCAS) warning on one or more aircraft under these circumstances, and the resolution advisory (RA) often is to continue the ongoing climb or descent. When this occurs, the SFL indication quickly becomes meaningless, and a situation the controller had every reason to believe was under



London's complex airspace can trip up infrequent visitors

Business Aviation and
Level Busts (cont'd)

control can quickly become a level bust. This is one of the reasons an "incorrect response to TCAS" might be attributed to a level bust, even though the actual response to the RA may have been correct.

In fact, an incorrect response to TCAS is recorded in half the level bust events.

Analyses of TCAS-related events by the NATS TCAS Working Group have found three major contributory factors. The most numerous by far were aircraft with high rates of climb or descent approaching the cleared level; around 75 percent of recorded TCAS events involve aircraft cleared to vertically separated levels generating 'nuisance' TCAS RA manoeuvres. Incorrect responses to TCAS RAs were less frequent, but often had far more serious consequences.

The causes behind an incorrect TCAS response varied. In some, crews reported choosing not to follow the RA to maintain passenger comfort or because they had visually acquired the other aircraft in the encounter. A more common cause was misinterpreting an RA, in particular misunderstanding an "adjust vertical speed" RA, an instruction to reduce the rate of climb or descent.

Pete Riley

Manager Safety Performance, within NATS Division of Safety, he is primarily responsible for providing safety assurance on NATS Airport and Centres to the Director of Safety and for teaching operational staff how to do ATC Procedure Risk Assessments; he was also until recently the NATS Level Bust Workstream Lead.

A normal TCAS response also can cause pilots to fail to maintain their ATC-cleared level when correctly following an RA; for example, an aircraft is climbed to a level with 1000 ft standard separation below another aircraft and receives an "adjust vertical speed" RA. While staying within the green arc of the TCAS climb/descent guidance, the aircraft can level at 600' beneath the traffic, preventing a collision but eroding standard ATC separation.

The increased risk of non-response, late response or incorrect response to TCAS — as well as possible pilot slow reporting of a deviation in response to a TCAS RA — are some of the many issues that have been identified as being more common in single-pilot operations. The introduction of very light jets (VLJs), particularly when operating with one pilot, complicates this picture. Although low performance VLJs are likely to be treated from a controlling perspective much the same way as current turboprops, mid-performance VLJs will have higher cruising levels combined with slower speeds than other aircraft at those levels. This is likely to add to controller workload, and, given the evidence of incorrect response to TCAS already identified, NATS will need to monitor closely the level bust performance of single pilot aircraft.

For NATS, having identified the level bust trend in the business aviation sector, the greatest challenge is to reach the correct audience with its mitigations. NATS has a very successful safety partnership agreement with many commercial operators in which it exchanges data and discusses issues in an open and frank forum. It also provides on a quarterly basis specific data on level bust performance to nearly 50 operators, including some business jet fleet operators such as Netjets.

However, for the business aviation community beyond the U.K. Air Operator's Certificate-holder sector, it has proven very difficult to reach the crews in an effective way. Small operators are too numerous, transitory, dispersed and infrequent U.K. airspace visitors to develop the longer-term relationship necessary to bring down level bust numbers. NATS has worked to develop ties with trade associations and simulator service providers, and has taken advantage of relationships with local handling agents to provide publicity and awareness initiatives. Ultimately, however, these strategies do not address the fundamental issue of directly engaging the target audience.

In an attempt to go further in addressing this issue, NATS has created a new workstream whose focus is on business aviation, as well as cooperating with the Business Aviation Safety Partnership. The work of these groups will consider the following areas:

Training

- Joint training initiatives such as sending controllers to simulator training establishments and participating in multi crew resource management, which includes business aviation pilots and controllers discussing situations from both perspectives.

Regulation

- Promoting carriage of specific avionic equipment, such as Mode S and, in some airspace, airborne collision avoidance systems;
- Adequate licensing, training and competency arrangements to expand knowledge of TCAS responses and airspace, airports and poor weather operations.

Briefing

- Facilitate access to adequate briefing material through handling agents, etc. NATS has recently produced, in conjunction with Flight Safety International and EUROCONTROL, a DVD for TCAS interpretation to supplement TCAS training;
- Encourage correct briefing by the operators.

The focus of these groups is supported by the recent publication of the Business Jet Safety Research Report, a Statistical Review and Questionnaire Study of Safety Issues connected with Business Jets in the UK. This, in turn, has resulted in the formulation of a U.K. Civil Aviation Authority-led Safety Action Plan for Business Aviation. Although the work is not yet finalised in this area, it is clear that the need for specific attention to be given to this sector of the aviation industry is greater than ever. ■

BEST PRACTICE/GOOD CONTROLLING [1]

1- The best practices/good controlling practices are not necessarily ICAO compliant

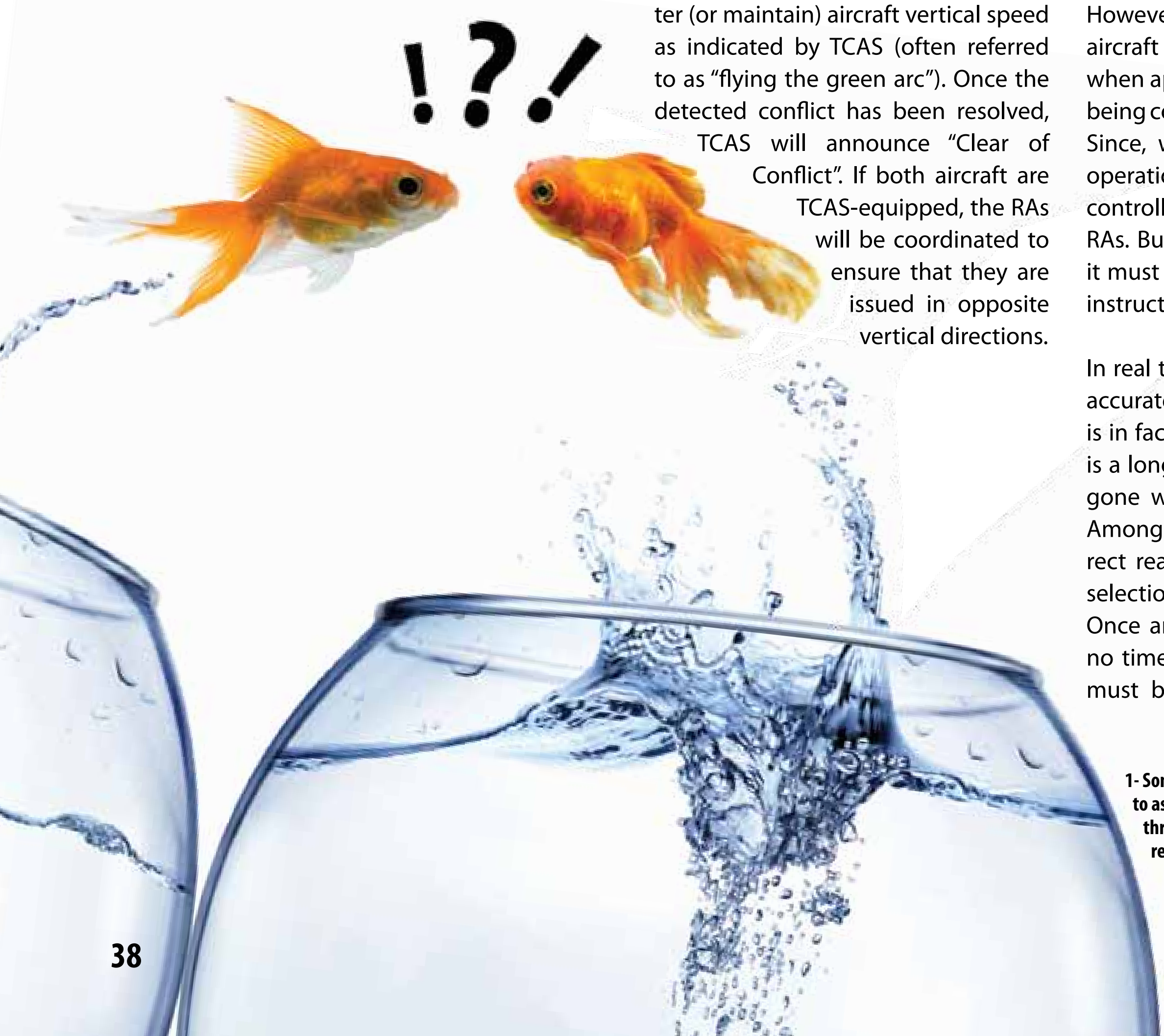
1.	**Phraseology**
1.1	Add the word 'degrees' to all heading instructions (except during surveillance or precision radar approaches).
1.2	Expect clearances; There have been level busts caused by crews confusing the expect level with their cleared level. If possible don't use expect clearances, if they are required then put the expect level first then the clearance, I.E. BAW123 expect FL150 level BNN, descend now FL210.
1.3	The word 'hectopascals' should be used in all cases when the QNH or QFE are passed, irrespective of the value of the pressure setting i.e. above or below 1000mb.
1.4	Take particular care when issuing a clearance to FL One Hundred or FL110.
1.5	Use clear and unambiguous phraseology at all times; **challenge poor RTF.**
1.6	The Prevented Level Bust Trial indicated particular problems with the misinterpretation of the digits '2' and '3'. Consequently controllers should be meticulous in using ICAO pronunciation for these digits (TOO) and (TREE) when issuing level clearances.
1.7	Only give two instructions which require a read back in a single transmission.
1.8	When passing traffic information, do not mention the actual level of the other traffic but pass this in terms of "XXXX feet below your cleared level" or "XXXX feet above you" etc.
1.9	Keep frequency change instructions separate from other instructions where possible.
1.10	Do not restate a cleared level if the pilot has already correctly read it back because the act of restating can introduce the opportunity for error. You do not need to repeat Flight Level information already passed correctly by pilots.
1.11	Use standard phraseology in face-to-face and telephone coordination.
1.12	Aim to keep RTF delivery measured, clear and concise, especially when the frequency is congested. But, if it's urgent, **sound urgent!**
2.	**Read backs**
2.1	Minimise the risk of wrong read backs by using simple and correct phraseology. Listen to the whole read back - check that it is completely accurate. Always insist on complete and accurate read backs from pilots. Listen and respond to any uncertainty or questioning in a read back. Refrain from other tasks whilst listening to a read back. If in any doubt - get a repeat. If you hear a double transmission - sort it out. Keep a quiet working environment to aid concentration. Minimise distractions – especially the telephone.
2.2	Use the Write **As You** Speak **R**ead **As You** **L**isten technique to help ensure that you actively monitor the read back from the pilot.
3.	**Detection of a level bust**
3.1	RT tapes on level busts record that the first action of the controller is often to confirm the level of the 'offending' aircraft. This invariably confirms that the aircraft has bust its level and that the Mode C that we are receiving is correct. In cases where the aircraft is thereby brought into conflict with another, this can lose valuable time which can be used to resolve the confliction. It is recommended that the first transmission should be to ensure separation, any debate about the cause of the level bust can wait until after the resolution of any conflict.
4.	**Procedures**
4.1	GMC methodology ~ as part of runway safety and of level bust amelioration measures, adopt a 'No ATC clearance received, then no taxi clearance given' policy.
4.2	Whenever possible allow pilots to fly the procedure that they have briefed. For example, ■ reduce or remove the number of changes to ATC departure clearances prior to departure. If such changes are unavoidable then the earlier the changes are passed the better ■ Allow pilots to fly a standard missed approach unless a change is required to achieve separation
4.3	If there is any doubt expressed, implied or suspected during the readback of a departure clearance or if the pilot advises that the departure clearance passed if different to the planned departure-confirm the SID or departure level.
4.4	Whenever possible, if a pilot reports receiving an ATIS broadcast which is no longer current, highlight any significant changes to avoid one member of the crew going off air to listen to the current ATIS.
5.	**Sector Manning**
5.1	Create r/t time - split sectors.

TCAS II and Level Bust

In an issue of HindSight dedicated to level bust, it is important also to mention the Traffic alert and Collision Avoidance System (TCAS II). Acting as the last safety barrier, TCAS is designed to mitigate imminent risks of collision, including those resulting from a level bust, by generating Resolution Advisories (RAs) to pilots...

By Stanislaw Drozdowski, EUROCONTROL

But TCAS is neither designed nor intended to prevent the occurrence of level busts – RAs will only be generated if another aircraft is in the vicinity. There have been several instances in which TCAS has "saved the day" by preventing serious incidents after a level bust. On the other hand, although the risk of collision was avoided, in some cases the following of TCAS RAs contributed to level bust occurring.



In this article I will look into the role of TCAS in level bust situations, give examples of its operations and provide statistics about the frequency of RAs in European airspace.

Nuisance RAs?

TCAS issues RAs when it calculates a risk of collision within a specified, altitude-dependent time threshold. On receiving an RA the pilot shall alter (or maintain) aircraft vertical speed as indicated by TCAS (often referred to as "flying the green arc"). Once the detected conflict has been resolved, TCAS will announce "Clear of Conflict". If both aircraft are TCAS-equipped, the RAs will be coordinated to ensure that they are issued in opposite vertical directions.

In order to be fully effective as a last-resort safety net, TCAS does not know the cleared level of either the aircraft on which it is installed or that of the intruder. TCAS predicts time to collision based on the closing and vertical speeds, it does not take into account any flight management system inputs or autopilot settings. That is one of the features that allows TCAS to mitigate human and other errors.

However, because TCAS does not know aircraft intentions, RAs can be issued when appropriate ATC instructions are being correctly followed by the aircraft. Since, with hindsight, these RAs are operationally not required, pilots and controllers refer to them as "nuisance"[1] RAs. But once an RA has been issued, it must take precedence over any ATC instructions.

In real time, the pilot cannot make an accurate assessment of whether the RA is in fact operationally required. There is a long list of things that could have gone wrong to lead to a level bust. Amongst these, undetected incorrect readback or wrong cleared level selection come to mind immediately. Once an RA has been issued there is no time to seek clarification – the RA must be responded to immediately.

1- Sometimes, these RAs are incorrectly referred to as "false RAs". A "false RA" occurs if there is no threat (other aircraft) which meets TCAS logic requirements for the generation of an RA.

Stanislaw Drozdowski

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The pilot also cannot know what the other aircraft in conflict is going to do. Is it going to level off as cleared? Was the clearance correct? Nobody really knows how the situation is going to develop.

The pilot has no choice but to follow the RA – that is dictated by regulations and common sense. Later, with the benefit of hindsight, it may be determined whether an RA was operationally required or a nuisance.

Why are RAs generated in level-off encounters?

Let's look at a scenario that involves one aircraft in a level flight and the other climbing (or descending) to its cleared level 1000 feet below (or above) – so-called 1000-foot level-off encounters.

Many jets can easily climb and descend several thousand feet a minute and the pilots often maintain high vertical rates very close to the cleared level. Based on these high vertical rates TCAS calculations may indicate a collision threat with another aircraft in the vicinity. Consequently, an RA will be generated. In the case of two aircraft descending and climbing towards each other, their combined closing speed will make RAs even more likely.

The illustration below gives a real-life example of how these RAs occur. A B767 was level at FL320 and an opposite-direction A319 was cleared to FL310 (which was correctly acknowledged by the crew). The Airbus climbed at 3100 ft/min. At this altitude the time threshold for RA generation is 35 seconds. With this vertical closure speed of 3100 ft/min, 35 seconds corresponds to 1800 ft. As a result, the Airbus received an "Adjust Vertical Speed" RA 1800 feet before its cleared level as TCAS detected a threat (the B767). The Airbus pilot followed the RA, reducing the aircraft's vertical speed to 2000 ft/min, and received a "Clear of Conflict" message before reaching its cleared level. The Boeing did not receive an RA as narrower parameters for RA generation apply to aircraft in a level flight.

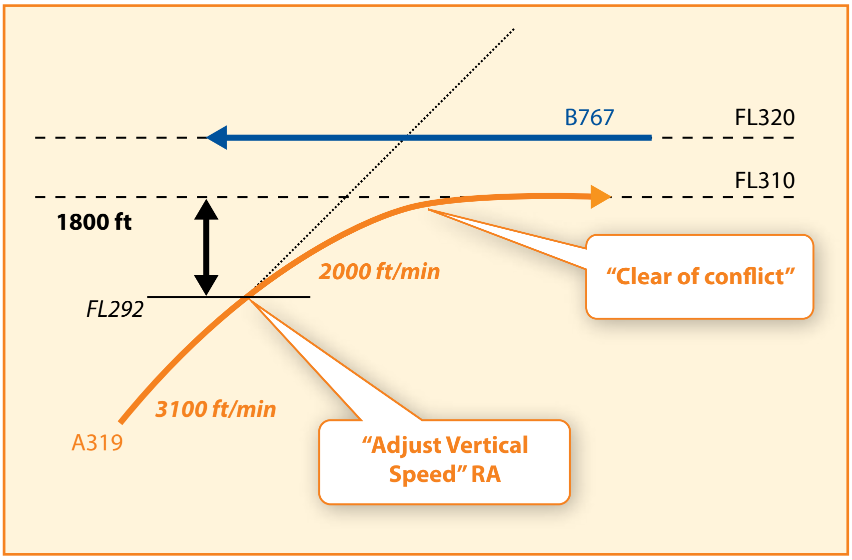
If the reduction of vertical speed had not been prompt enough, the RA would have been strengthened and issued to both aircraft involved (typically "Climb" and "Descend", respectively).

The "Adjust Vertical Speed" RA that TCAS will issue to a fast climbing or descending aircraft calls for a reduction (never an increase) of the vertical speed to not greater than the limit indicated on the TCAS display - to 2000, 1000, 500 or 0 (i.e. level-off) ft/min.

Once an RA has been issued, it must take precedence over any ATC instructions.

Many of these "Adjust Vertical Speed" RAs will not cause an aircraft to depart from the current ATC clearance or instruction and, therefore, pilots do not have to report them. However, if an RA report has been received, the controller shall not attempt to issue any instructions to the reporting aircraft until the pilot reports "Clear of Conflict".

New ICAO provisions that were put in place in November 2008 recommend that the pilots reduce their vertical to 1500 ft/min in the last 1000 feet be-



TCAS II and Level Bust (cont'd)

fore the level-off[2]. That should contribute to a reduction in the number of these RAs.

In some cases, following an "Adjust Vertical Speed" RA may cause the aircraft to bust its cleared level when levelling at the cleared level would have been perfectly safe. This happens because TCAS chooses RAs which minimise the manoeuvre from the current trajectory – in the case of fast climbing and descending aircraft it will be the reduction of their vertical speed, i.e. the "Adjust Vertical Speed" RA. If the "Clear of Conflict" message is not posted before the aircraft reaches its cleared level (remember, TCAS does not know the cleared level), the pilot will continue to fly "the green arc" through the cleared level and a level bust will occur. These level busts are usually minimal and, in any case, if the aircraft get too close the RA will be strengthened or reversed.

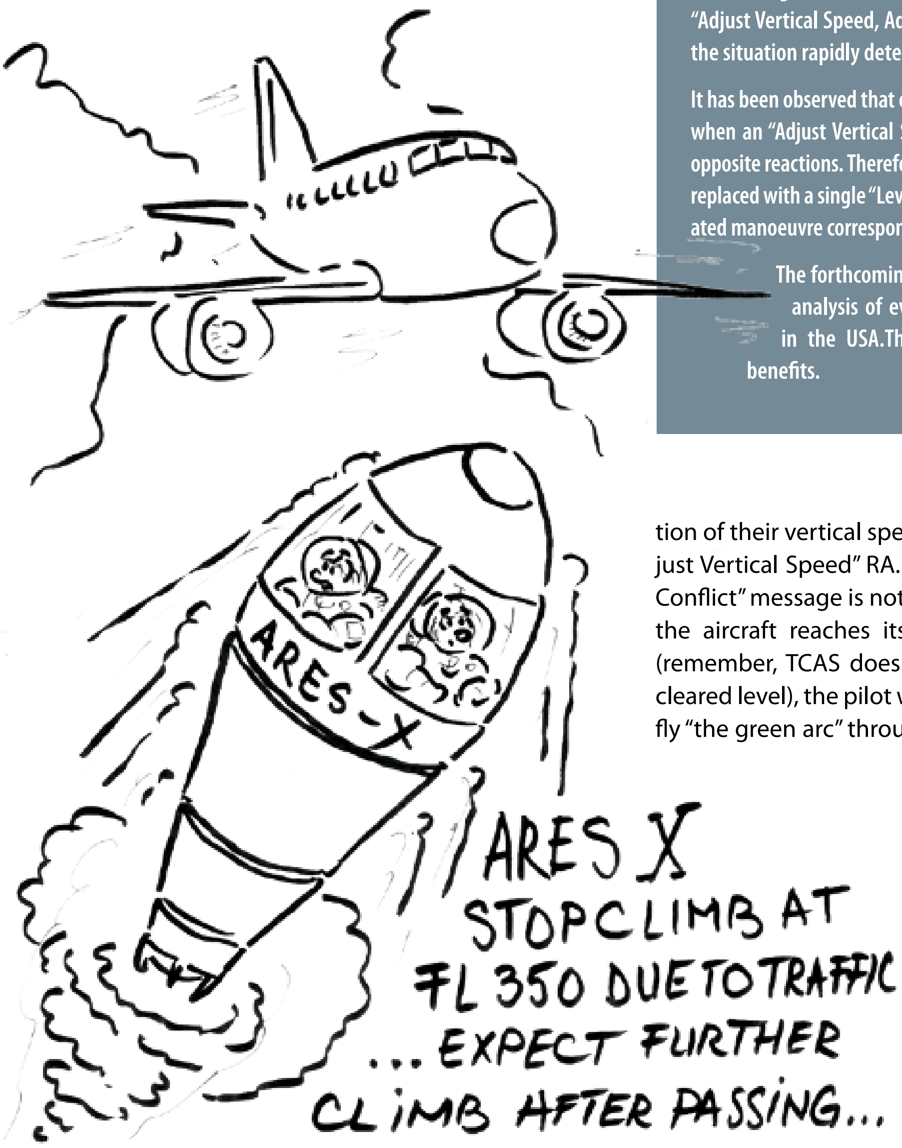
The forthcoming TCAS version 7.1 will replace all "Adjust Vertical Speed" RAs with a single "Level-off" RA (which is intended to address the issue mentioned above). Unfortunately, we are unlikely to see an aircraft with version 7.1 any time soon[3]. At the time of writing there has been no regulatory decision as to when version 7.1 will be implemented and the manufacturers will not have the software ready before the beginning of 2012.

New "Level-off" RA

One of the changes that will be brought about by TCAS II version 7.1 will be a new "Level-off" RA. With the existing version of TCAS numerous cases have been reported in which pilots responded to the "Adjust Vertical Speed, Adjust" RAs by increasing vertical speed instead of reducing it. As a result, the situation rapidly deteriorated.

It has been observed that enhancements in training alone can improve the behaviour of a flight crew when an "Adjust Vertical Speed, Adjust" RA is issued; however, they are not sufficient to avoid all opposite reactions. Therefore, to fully address the issue the "Adjust Vertical Speed, Adjust" RAs will be replaced with a single "Level-off" RA. The "Level-off" aural message is straightforward and the associated manoeuvre corresponds to the standard manoeuvre already performed in critical situations.

The forthcoming introduction of the new "Level-off" RA has been preceded by detailed analysis of events and radar data from core Europ an airspace and two busy TMAs in the USA.The studies concluded that the "Level-off" RA will bring operational benefits.



TCAS – preventing the consequences of level bust

The case described below shows how TCAS operates when a level bust has occurred and the aircraft are in horizontal proximity.

A Fokker 100 was at FL310 approaching its destination. The crew requested descent and was cleared to FL290, 1000 feet above a Boeing 737 in a level flight on a crossing track. However, the Fokker crew made an incorrect autopilot input indicating FL210 as their cleared level. The Fokker commenced a slow descent to FL288 when the crew received a TCAS RA to climb. Simultaneously, the crew of the B737 received an RA to descend. Both crews complied with their RAs promptly and both aircraft passed 1100 feet apart with horizontal spacing below 3 NM.

How often do RAs occur?

TCAS RAs are rare events. Extensive monitoring conducted from September 2007 to March 2008 in the core European airspace found that 743 aircraft were involved in 617 encounters in which at least one of the aircraft involved received an RA[4]. That gives an average of 3 RAs per day in the area covered by the study. The average duration of an RA was 33 seconds.

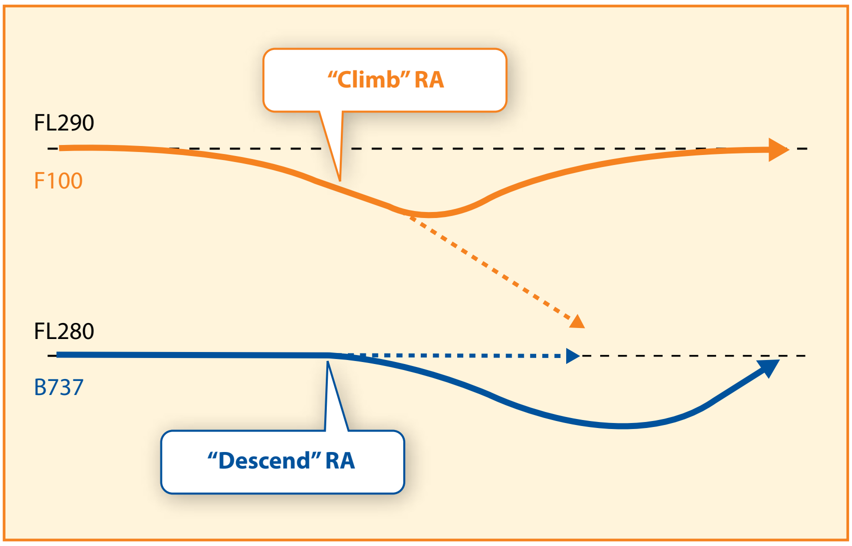
Only 17% of all encounters resulted in a coordinated RA (i.e. in 83% of the encounters, an RA was generated on board only one of the aircraft involved). Reasons for this include the geometry of the conflict being such that the RA was not generated on the threat aircraft or the threat aircraft was not TCAS-equipped.

The majority of RAs (61%) were solely "Adjust Vertical Speed" RAs. In 2% of cases "Adjust Vertical Speed" RAs were followed by either a "Climb" or "Descend" RA – these are the cases in which a level bust most likely occurred or was about to.

It is not known how many RAs happened outside the area covered by the study but it has been estimated (using the number of flight hours in the area covered by monitoring and in the whole of European airspace) that some 18 RA encounters happen each day in Europe as a whole.

Conclusions

RAs in 1000-foot level-off encounters generally occur due to high vertical speeds. Although some of these RAs are, with the benefit of hindsight, operationally not required, pilots are mandated to follow all RAs. If a level bust occurs, TCAS will issue an RA that, if followed correctly, will resolve an imminent risk collision. ■



2 - Doc. 8168, vol. 1, para. 3.3: "Pilots should use appropriate procedures by which an aeroplane climbing or descending to an assigned altitude or flight level, especially with an autopilot engaged, may do so at a rate less than 8 m/s (or 1 500 ft/min) throughout the last 300 m (or 1 000 ft) of climb or descent to the assigned altitude or flight level when the pilot is made aware of another aircraft at or approaching an adjacent altitude or flight level, unless otherwise instructed by ATC. These procedures are intended to avoid unnecessary airborne collision avoidance system (ACAS II) resolution advisories in aircraft at or approaching adjacent altitudes or flight levels. For commercial operations, these procedures should be specified by the operator."

3 - Once the implementation schedule of TCAS II version 7.1 is known we will provide readers with detailed information about changes that the new TCAS version brings.

4 - For more information see http://www.eurocontrol.int/safety-nets/public/standard_page/PASS.html

MODE S
Helping to reduce risk

Mode S has been around for many years but for various reasons its implementation as a surveillance technology and ATS support tool has been a long time coming – too long for many people in the ATC world. However we are now seeing the technology come on line in many European States and the benefits are beginning to be realised.

By Andy Edmunds, NATS, UK

There are two levels of Mode S, Elementary and Enhanced.

- Elementary Mode S (ELS) allows selective interrogation of aircraft providing the potential to eliminate Garbling and Fruiting. Additionally, ELS includes the aircraft identification Down-link Airborne Parameter (DAP).

- Enhanced Mode S (EHS) provides the functionality of ELS plus additional DAPs, including ground speed, indicated airspeed, heading and the Selected Altitude entered by the crew into the Mode Control Panel (MCP) or Flight Control Unit (FCU). Fig 1 shows a typical MCP unit.

Fig 1: Typical Mode Control Panel showing selected altitude of 23000

So as well as more robust surveillance data, Mode S DAPs now provide the ATS provider with much more information on what the aircraft is actually doing and, more pertinently, intent data.

What's the problem?

In the late 1990s, the UK CAA produced a report which captured the main underlying causes of level busts and its recommendations have since been progressed. Yet these events still occur and last year NATS experienced about 400 instances. Although not all level busts lead to losses of separation, their large number poses a potential risk to the ATC operation and so on the back of the CAA report, NATS started the Level Best campaign.

Through a mixed programme of live presentations to operators with radar recordings of real busts, a video training package, magazine articles, posters and a website, the programme aimed to raise awareness of this issue within the aviation community. As part of this in 2006 NATS conducted an internal Prevented Level Bust Trial which in a 10-day period recorded some 1454 level busts or potential level busts which were prevented by the intervention of the controller. Many of these involved the aircraft not stating its cleared level on first contact. The Level Best campaign was specifically intended to see:

- An **increase** in the proportion of level busts reported, to understand the scale of the problem
- A **decrease** in the number of events leading to a loss of separation

Awareness and education are often effective in changing behaviour so NATS sends level bust performance data out to 45 or so individual operators, highlighting the operator's individual performance compared to the average for the group. We also show the operator's position within a league table! For some operators we have sent out trend analysis of causal factors, type, level, position, etc. to help identify any peculiarities associated with particular fleets or bases. The data is very much appreciated by the airlines and is often used as a key performance indicator by them. Also as a result of such data analysis, the UK CAA has written to the National Supervisory Authority of two foreign operators highlighting poor level bust performance.

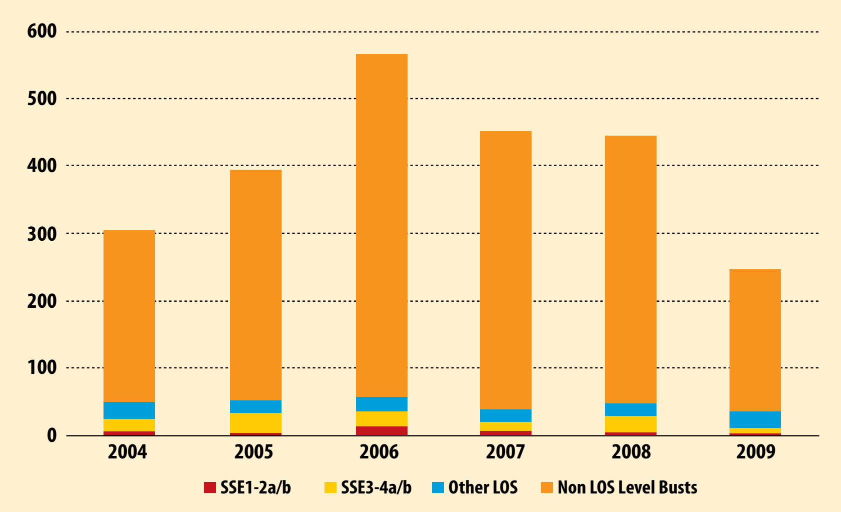


Fig 2: NATS UK Level Bust data from 2004 to date

The number of reported level busts within UK airspace where NATS is the controlling authority is shown in Fig 2. The events for each year are broken down into differing levels of severity (SSE is a NATS severity classification) and it may be concluded that the peak in 2006 was the result of a steady increase in level busts in line with overall traffic growth. This may be the case but the trend could also be attributed to an increase in open reporting as a consequence of internal safety initiatives and the Level Best campaign.

With the same level of reporting and rising traffic levels, the drop in 2007 may be attributable to an increasing awareness of the issue and level busts being caught before they happen. The story for 2008 is largely similar although the downturn at the end of that year and in 2009 will also have a bearing.

Drilling down into each event identifies one or more causal factors and Fig 3 shows these for the level busts in 2008.

It is noticeable that correct pilot readback followed by incorrect action was by far the commonest causal factor ▶

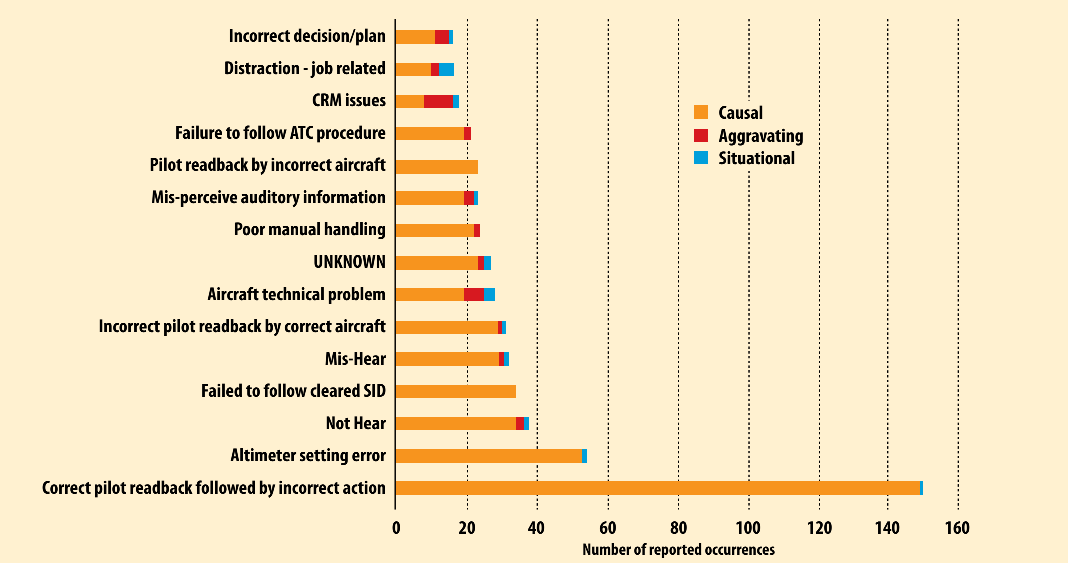


Fig 3: Causal factors for level busts in 2008

MODE S
Helping to reduce risk (cont'd)

although it should be noted that in reality this set represents 'what happened' and not 'why it happened'. Assuming other factors may have contributed to the eventual outcome, nevertheless this group represents the biggest problem of a pilot saying one thing and doing another. This is where prevention of risk is problematic but Mode S functionality has proven most beneficial in this respect.

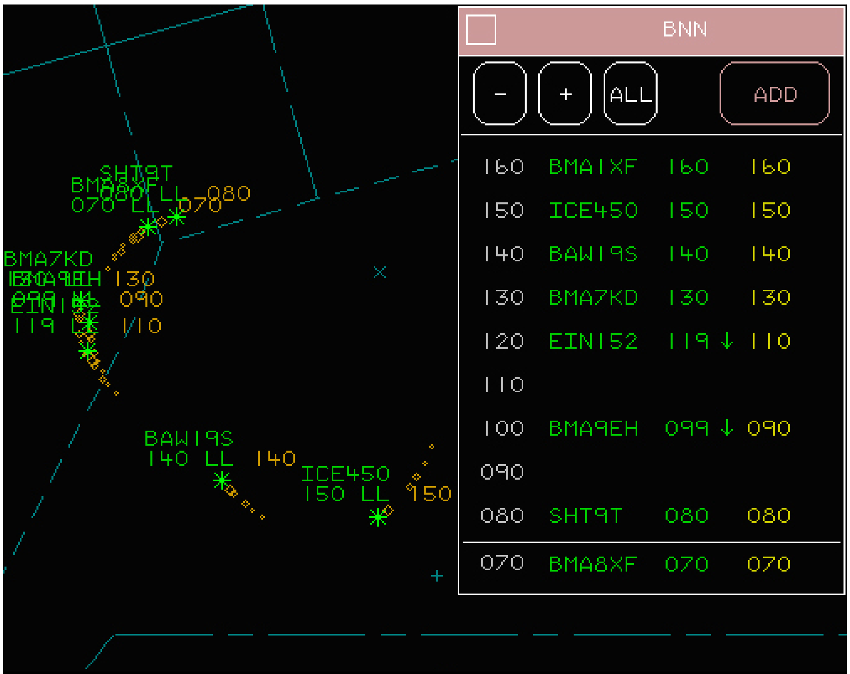


Fig 4: Vertical Stack List for the Heathrow Bovingdon hold.

Fig 5: EHS information in the aircraft Target Label

Mode S Selected Altitude DAP – How is it used?

In December 2005 NATS enabled the display of Mode S EHS data in the London Terminal Control (LTC) operation and introduced new support tools intended to provide positive safety and efficiency benefits. The introduction was supplemented by a UK CAA regulatory mandate for aircraft flying into London Terminal airspace to be Mode S EHS equipped.

The Vertical Stack List (VSL) tool provides a plan view of the London holding stacks. Fig 4 shows the Bovingdon hold and on the left is the normal surveillance picture of the hold with a lot of garbling. On the right is the VSL showing level occupancy, actual altitude and in orange the Selected Altitude DAP. The tool not only enhances controllers' vertical stack awareness but also provides a warning of a potential level bust.

Outside the inner holding areas, the Selected Altitude DAP can also be displayed for any aircraft within LTC airspace. Fig 5 shows the Target Label of BMA3XF. The altitude readout and destination code are shown in line 2, along with the MCP/FCU altitude selected by the pilot (dark orange to distinguish it from the actual altitude). BMA3XF has selected 15000 feet and is passing Flight Level 165. Other DAPs such as Ground Speed, Indicated Air Speed, and Magnetic Heading can also be displayed in line 3 of the Target Label and in this case the aircraft's magnetic heading has been selected.

All UK ACCs and TMAs will have the capability to display Mode S DAPs by the end of 2010 and this functionality is now also increasingly available at UK airports where Mode S EHS surveillance systems have been installed.

Human workload limitations and time delays incurred whilst flight crew input information into the MCP/FCU must be taken into account. Therefore, the requirement for aircrew to read back all clearances and for controllers to check the readback still applies and recognition of the Selected Altitude does not constitute confirmation of the clearance. However if the controller detects an anomaly, the UK has published specific phraseology to ask the pilot to check the cleared level but without stating the observed incorrect level:

> "(Callsign), check selected level. Cleared level is (correct cleared level)".

Selected Altitude data is presented as either a flight level or an altitude, depending on local surveillance system settings. In the UK, for ATC and RTF phraseology purposes, the generic phase 'Selected Level' is used to mean data presented as either an altitude or a flight level.

Has it been worth it?

In justifying the implementation of EHS functionality within LTC airspace, it was predicted that in 2006 the system would provide a quantifiable safety benefit in the prevention of level busts, compared to 2005 data. Of the many 'causal factors' (see Fig 3), the following were chosen as being preventable by EHS:

- Correct pilot readback followed by incorrect action.
- Incorrect pilot readback by correct aircraft.
- Pilot readback by incorrect aircraft

The results? Well, we found that overall there had been a 63% reduction in the level of risk exposure associated with these causal factors, expressed as the severity of the consequent level bust. Statistical headlines never tell the whole story and other factors undoubtedly influenced events. However, set against rising traffic levels for the years in question and no other system support tools, this improvement is significant and we feel the project achieved what it set out to do.

Although not a scientific endorsement of the tool, LTC controllers have now had a number of years' experience using the Selected Altitude DAP and the view from the shop floor is that it's something they would not want to live without.

SELECTED ALTITUDE IN ACTION

The following are extracts from reports where EHS Selected Altitude has or might have prevented a level bust.

- *A319 given descent to FL130, but crew selected FL110 which was showing on Mode S. ATC queried this with the crew, who stated it was a mistake. Standard separation maintained.*
- *The controller intended to climb Aircraft A to FL170 and turn it left heading 315. However, he transposed the callsign and issued the instruction to a similar company callsign (Aircraft B). The controller saw the selected level on Aircraft B change to FL170 and the a/c turn slightly, at which point he recognised his mistake and took appropriate remedial avoiding action. Standard separation was maintained.*

The following incident occurred in London Area Control airspace where the Centre does not yet have Mode S capability. Callsign 1 was cleared to FL370 on top of Callsign 2 (the orange 31▽ symbol is an electronic inter-sector coordination function and is not related to the incident). Unfortunately the pilot read back FL310 as the cleared level and this incorrect readback was not picked up by the controller. The aircraft subsequently descended through FL360 and there was a loss of separation.

The same scenario recorded from the London TerminalControl radar display and it clearly shows the pilot of Callsign 1 has input FL310 as the Selected Altitude. This error could have been picked up by the area controller had the functionality been available.

MODE S
Helping to reduce risk (cont'd)

Concurrent with the introduction of Mode S EHS tools, NATS has seen a marked reduction in exposure to risk in a busy TMA environment.

Nothing is perfect

Whilst the display of Selected Altitude is an obvious safety enhancement, there are occasions where despite the flight crew complying with the ATC clearance, the displayed Selected Altitude is different:

- Along SIDs/STARs with vertical restrictions where pilots may select the final cleared level, and utilise the aircraft flight management system to achieve the vertical constraints.
- During final approach where pilots may pre-select the Missed Approach Point altitude. To avoid any confusion the EHS information is removed from the target label.
- When the aircraft is being flown manually.
- Where there is an incorrect barometric pressure setting.

A review of UK Mandatory Occurrence Reporting data from the introduction of EHS in LTC airspace in December 2005 to the present did not find any instances of data corruption between the altitude set by the pilot in the MCP/FCU and the DAP displayed to the controller. However, the review did identify 35 instances of autopilot failure to capture the Selected Altitude. Therefore regardless of the apparent accuracy of the Selected Altitude, controllers should always remain alert to the potential for non capture and subsequent level bust.

Of course, the full value of the tool is reduced where the Selected Altitude DAP is not available, either because there is a fault with the Mode S transponder or because the aircraft is not suitably equipped.

Looking ahead

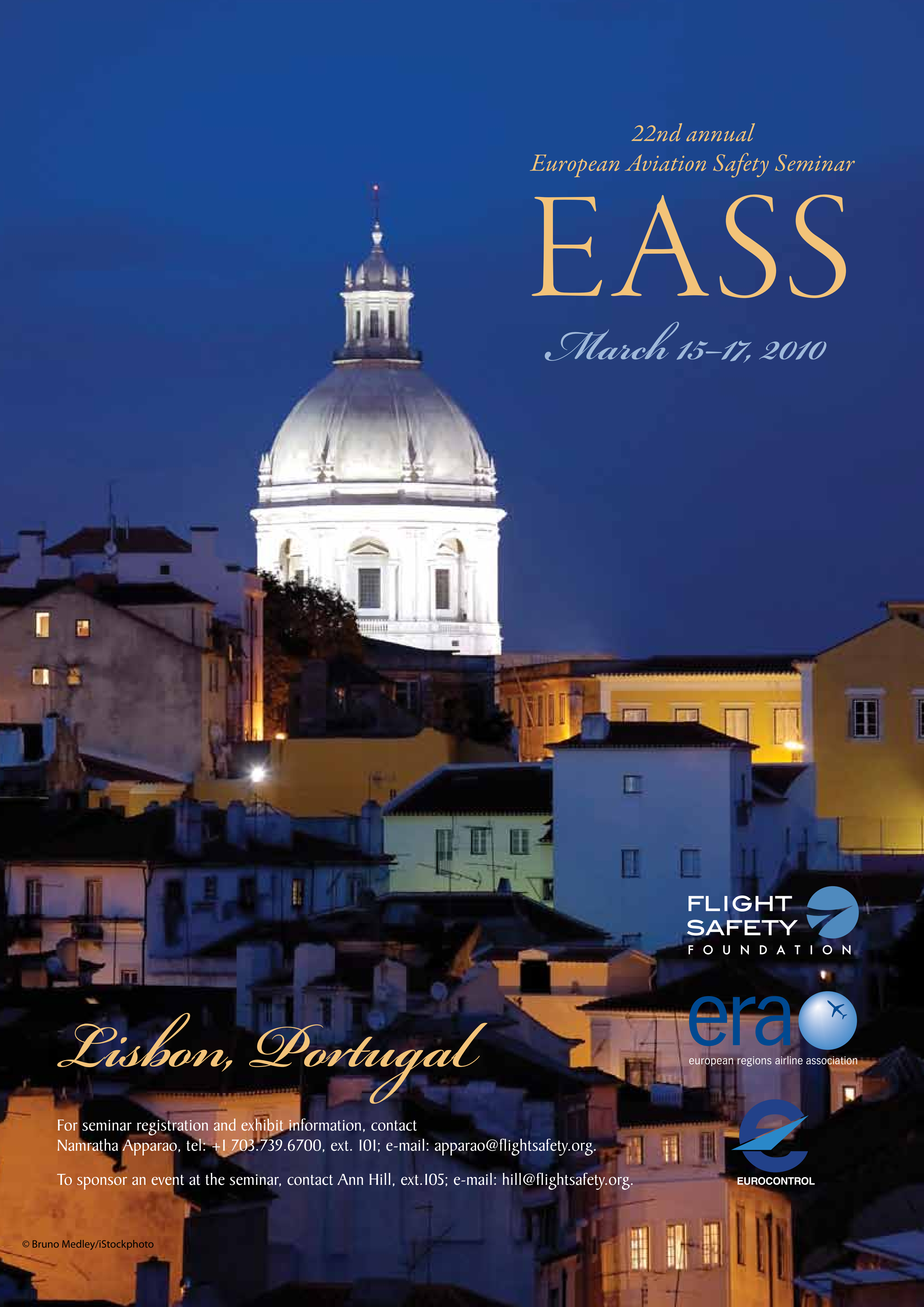
Concurrent with the introduction of Mode S EHS tools, NATS has seen a marked reduction in exposure to risk in a busy TMA environment. The roll-out of the tools to other areas of UK airspace should see a similar improvement.

Further enhancements can be made because at the moment prevention requires the controller to manually observe the Selected Altitude and compare it to the cleared level. There is no guarantee that a controller can carry out such a task at all times and incorrect settings may still occur. With the introduction of electronic flight data in the near future, we can then provide system support in this area by automatically alerting the controller to a discrepancy, so reducing risk even further.

Mode S has been a long time coming, but now it's here, it's showing its worth. ■

Andy Edmunds

After serving in the RAF, he joined NATS in the early 1990's as an en-route ATCO at the London Centre. He has since had experience in Unit Operations departments and has managed Systems and ATCO Competency teams. Currently he is an ATM Policy expert at NATS Corporate & Technical Centre at Fareham, responsible for managing operational risk and providing NATS' Unit customer support and he still retains an operational validation at the Swanwick Centre.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Air Traffic Controllers do it too!

For a number of years now, my colleagues and I have been studying multitasking in the cockpit and have made a number of observations[1,2]...

By Loukia D. Loukopoulos

Multitasking, the act of performing more than one task at the same time, is a highly prevalent and practically inevitable practice in the cockpit because of multiple, concurrent operational demands. Pilots regularly multitask with confidence and a business-as-usual attitude and they, like all humans, over-estimate their ability to multitask successfully. They readily accept the challenge without full appreciation of the risk(s) they take when doing so. Whilst multitasking pilots have a very high rate of success, errors and compromises to safety still occur.

To derive these observations, we first analysed flight operations manuals (and the training based on these manuals) and determined that the tasks regularly performed by pilots during routine flights are, in theory at least:

(a) **linear** – first do one task, then the next, then the one after that, etc., always in the same sequence

(b) **predictable** – externally-provided information and other cues are always present, at the time they are needed

(c) **controllable** – pilots have full control of the timing of activities and the time available to complete them

Next, we observed operations from the cockpit jumpseat, with a fair degree of appreciation that the real world would not be quite as "clean" as that expressed on paper. Indeed, we discovered that even the most routine of flights is far more dynamic and unpredictable than anticipated because of a large volume of perturbations – normal (i.e., not emergency) operational events that are familiar but nonetheless often unpredictable in their content and/or their timing. To address such perturbations pilots weave their responses within the linear and predictable sequence of cockpit tasks and end up with a dynamic, unpredictable situation over whose timing they ultimately have less than full control. Pilots treat such situations as just another day on the job. Incident reports, however, show that a large number and variety of errors can be traced back to one under-appreciated culprit: multitasking.

Of course pilots are no exception – our observations about multitasking extend well beyond the cockpit to all operators working in highly-complex and safety-critical jobs. Like, say, air traffic controllers…

Loukia Loukopoulos

has a PhD in Cognitive Psychology and an Aerospace Experimental Psychology designation from the United States Navy where she served before joining NASA Ames' Human Systems Integration Division.

She is currently also a human factors consultant to the Hellenic Air Accident Investigation and Aviation Safety Board and involved in a number of aviation human factors research and teaching activities.

This article is a first attempt to look at the air traffic control environment using controllers' own reports of their operational errors at facilities in the USA.[3] Reports were selected to show that multitasking situations arise from the presence of operational perturbations to ATC tasks. Like pilots, controllers' attempts to multitask in response to these perturbations increase the potential for errors.

Let's look at some of the examples we found:

"I HAD TRAFFIC LANDING ON BOTH RUNWAYS 28 [L AND R] WITH ANOTHER PAIR OF ARRIVALS APPROACHING THE 2 MILE FINAL… AIRCRAFT Y WAS HOLDING IN POSITION ON RUNWAY 1R. AIRCRAFT X WAS HOLDING IN POSITION ON RUNWAY 1L WITH A WHEELS-UP TIME [COMING UP SHORTLY]… I CLEARED AIRCRAFT Y AND AIRCRAFT X [FOR TAKEOFF] IN A TIGHT HOLE WITH LANDING TRAFFIC ON A 2 MILE FINAL… BECAUSE I WANTED TO MAKE THE WHEELS-UP TIME [OF AIRCRAFT X]… I DID NOT NOTICE THAT AIRCRAFT X WAS… ON THE SAME DEPARTURE SID THAT AIRCRAFT Y WAS ON [BOTH WOULD BE MAKING RIGHT TURNS AFTER TAKEOFF]… [THESE] FLIGHTS [DEPARTING 1L] USUALLY GET [A LEFT TURN DEPARTURE]… AIRCRAFT X WAS REROUTED AND TAXIED TO RUNWAY 1L BY GROUND CONTROL BUT NOT MARKED WITH RED "L" ON THE AIRCRAFT STRIP [BY GROUND CONTROL]. MY ATTENTION WAS PRIMARILY FOCUSED ON THE LANDING RUNWAYS TO ENSURE THAT THEY WERE CLEAR ON FINALS." (ASRS REPORT 784838, MAY 2008)

Coordinating arrivals and departures at the airport ranked number 24 in the world in terms of aircraft movements is not an easy matter, but it is business as usual for an appropriately trained and experienced controller. To respond to the demands of the situation, she[4] **switches attention** between the tasks at hand: coordinating the arriving aircraft, listening and responding to their radio calls, visually verifying their position and progress, issuing landing clearances, and monitoring to identify a "hole" in the stream of incoming traffic that will allow her to send the aircraft holding on the runway safely on their way. Interleaving tasks in this manner makes it possible to maintain a constant flow of incoming and outgoing aircraft without interruptions and delays, while meeting the operational goal of maximum throughput.

With few exceptions (highly automated tasks), humans are practically unable to do two things at the same time. Multitasking primarily relies on **interleaving** activities, that is, directing attention to one task for a short while, switching attention to another task, then back to the first task, and back and forth in this manner among all tasks at hand. Individuals vary in the number and type of tasks they can handle well in this manner but resources are always finite and, regardless of personal limits, everyone sacrifices attention to one task or aspect of the environment when forced to devote attention to another. This then means that the more tasks a controller does at the same time, the less attention he or she can pay to all the details and nuances involved in each and the less foresight he or she can have to consider, check, and respond to possible contingencies.

The aviation environment is highly proceduralised. This leads to expectations that events will take place in certain ways. It is natural for a controller experienced with operations at this airport to expect that an aircraft taking off from the left runway will be making a left turn. Had she not been busy interleaving the many other pressing demands, she might have been afforded the time and foresight to check that the two aircraft waiting to take off on parallel runways are not, in fact, on conflicting trajectories. Multitasking as she is, ▸

1- Loukopoulos, L.D., Dismukes, R.K., & Barshi, I. (2009) 'The Multitasking Myth: Handling Complexity in Real-World Operations'. Aldershot, Ashgate Publishing Limited

2- Loukopoulos, L.D., Dismukes, R.K., & Barshi, I. (2009) 'The Perils of Multitasking' in the August edition of 'Aero Safety World'. Flight Safety Foundation, pp. 18-23.

3- Reports were taken from the publicly-accessible U.S. Aviation Safety Reporting System (ASRS). The search criteria used were: type of error; air traffic control; the year range 2005-2009 and narratives to contain the word 'distract'

4- The controller's gender is not obvious from the reports – it is therefore randomly assigned to each narrative.

Air Traffic Controllers do it too! (cont'd)

however, the controller inadvertently "sheds" that portion of workload and relies on expectation alone. But contingencies – in this case, another controller not marking a change in routing on the aircraft flight strip – are always lurking around the corner.

The fact that aviation operations are highly structured around procedures means that humans, who are creatures of habit, learn through repeated practice and experience, to perform some tasks automatically, without much conscious effort. But functioning 'on autopilot' when multitasking is not always a good thing:

"I WAS WORKING SECTOR #9 BY MYSELF. SIGNIFICANT WEATHER, CAUSING NUMEROUS DEVIATIONS… SECTOR [#9] USUALLY COMBINED WITH SECTOR #8. TODAY, DUE TO VOLUME ISSUES AND WEATHER REROUTES, THE SECTORS WERE SPLIT. I ISSUED ALTERNATE ROUTINE TO AN AIRCRAFT… THINKING OF AVOIDING A BUSY SECTOR BY GOING UNDER IT… THE PROBLEM AROSE AS THE AIRCRAFT DESCENDED BELOW FL280, AS THAT AIRSPACE BELONGS TO SECTOR #8… I HAD INADVERTENTLY USED AIRSPACE THAT NORMALLY WOULD BE MINE BUT TODAY WAS NOT!" (ASRS REPORT 665421 – JULY 2005)

In this instance, under the strain of demands for multitasking of activities spurred by the volume of traffic and the weather, the controller subconsciously relies on a process normally used (and that through repetition, has become highly automated) to resolve a common coordination issue – and makes use of sector 8 to reroute an aircraft). In doing so, he forgets that today something is different - sectors 8 and 9 are split and he only has control of the latter.

As in cockpit operations, many operational perturbations demand intervention. In some instances, the intervention can be deferred to a later point in time, but in other cases, intervention must be immediate. This presents an interesting multitasking case, as it forces the interruption of ongoing activities which the operator is expected to resume after addressing the interruption:

"[AIRCRAFT X] DEPARTED… AND WAS VECTORED TO A 230 DEG HEADING [TO AVOID TRAFFIC IN THE AREA]… AS THE AIRCRAFT WAS CLEAR OF CONFLICTS, I CLIMBED IT TO 13000 FT. THE DEPARTURE ROUTE [OF THIS AIRCRAFT] IS THROUGH A 5 MI WIDE CLIMB CORRIDOR NEAR THE CORNER WHERE 5 FACILITIES AIRSPACE COME TOGETHER… I WAS DISTRACTED BY AN AIRCRAFT THAT I HAD ALREADY HANDED OFF TO A DIFFERENT SECTOR AND WAS ABOUT TO TRANSFER ITS COMMUNICATIONS. THE PILOT INFORMED ME THAT THE CEILING LOOKED LOWER AHEAD AND WOULD SOON NEED AN ALTITUDE CHANGE… THE OTHER SECTOR HAD JUST HANDED OFF A DIFFERENT AIRCRAFT HEAD-ON AT 5500 FT… AS I TOLD THE OTHER CONTROLLER ABOUT THE PILOT'S NEED FOR LOWER... AND POINTED OUT THE CONFLICT PREVENTING AN IMMEDIATE ALTITUDE CHANGE, AIRCRAFT X FLEW PAST THE CORRIDOR I WAS SUPPOSED TO TURN THEM INTO." (ASRS REPORT 808358, OCTOBER 2008)

The perturbation, in this case a routine operational request (a pilot requesting a lower altitude), arrives during an ongoing activity (monitoring a climbing aircraft to issue an instruction to turn when appropriate), and generates the need for a series of related activities (coordinate with another controller). Judging that there is some time remaining before the climbing aircraft will reach the turning point, and because resolving the developing conflict is clearly more urgent, the controller interrupts his monitoring of the aircraft and responds to the new demands created by the perturbation. He obviously fully intends to issue the turn instruction at the appropriate moment, but allows his attention to be diverted to another aspect of the environment to prevent the developing conflict. In doing so, he inadvertently loses track of time. In a matter of seconds, the intention to turn the climbing aircraft into a safe air corridor is forgotten, thus compromising the safety of an otherwise routine situation.

Forming the intention to do something in as little as a few seconds ahead of the present has the effect of engaging prospective memory, which is something none of us is terribly good at. It is difficult to monitor a situation actively, maintain an intention, determine when the time is right to perform it, and remember the full and correct content of that intention spontaneously with no external prompt. The probability of success is perhaps fair when workload is fairly low but decreases with the number of concurrent tasks being managed. Like pilots, controllers probably underestimate their vulnerability to errors of omission in these situations.

To reduce the chances of forgetting a deferred intention, pilots sometimes explicitly (or subconsciously) set cues to alert them when it is time to perform it. Controllers do it too:

"I WAS WORKING A BUSY SECTOR... I TOOK A HANDOFF ON AIRCRAFT X... DESCENDING FROM FL300 TO FL250… I NOTICED THE AIRCRAFT WAS HEADED FOR [A RESTRICTED AREA] … I DIDN'T HAVE TIME TO CALL THE CONTROLLER [WHO HANDED OFF THE AIRCRAFT]… I FIGURED I WOULD TURN THE AIRCRAFT WHEN IT CROSSED INTO MY AIRSPACE. THE AIRCRAFT NEVER CALLED ME… THE OTHER CONTROLLER PUT THE AIRCRAFT ON THE WRONG FREQUENCY… THAT WAS TOO BUSY TO ANSWER HIM, [THE AIRCRAFT] WENT BACK TO [THE ORIGINAL CONTROLLER] AND THEN FINALLY TO ME. BY THAT TIME HE HAD FLOWN THROUGH [THE RESTRICTED AREA]." (ASRS REPORT 651026 – MARCH 2005)

In this instance, the controller relies on a predictable cue (pilots establish radio contact with ATC when crossing airspace boundaries) to remember to perform an action (turn the aircraft away from a restricted area) that has to be deferred because she cannot accomplish right at that moment (there is no time to call the other controller). Associating (encoding) an intention with an event (cue) expected to occur at about the time when the intention will need to be performed is very good practice – it simply requires monitoring for that event to take place. Monitoring, as we already saw, however, is a tricky activity that requires discipline so that one can periodically self-interrupt ongoing activities to check on the event being monitored. That discipline is especially vulnerable to being inadvertently "dropped" during multitasking situations. To make matters worse, noticing the non-occurrence of an event is much harder than noticing its appearance. In this instance, when the cue (incoming call from aircraft) does not occur as anticipated, there is nothing to signal its absence – as a result, the associated intention is inadvertently overlooked.

These are just a few examples to illustrate that, like the cockpit, the ATC operating environment is inundated with "normal" perturbations to an otherwise highly proceduralised workload. Inclement weather, pilot requests, incorrect readback, similar call signs, splitting of sectors in real-time, working more than one position, noise, fatigue and congested radio frequencies - and the list goes on - can all intervene. Pilots deal with perturbations by multitasking – controllers do it too! Multitasking renders all humans vulnerable to errors, and this vulnerability is often poorly recognised. In our work with pilot operations, we have been suggesting ways to reduce the probability of errors brought about by multitasking. Further research is required to gain a better understanding of this inevitable feature of complexity in the ATM environment in order to eventually suggest ways to ease the effects of multitasking in air traffic control operations as well. ■

Pilots deal with perturbations by multitasking – controllers do it too!

Setting cleared altitude – What happens in the multi crew flight deck?

The way cleared altitude is selected and associated changes are made to FMS Modes is predicated on the way responsibilities are shared between the 'Pilot Flying' (PF) and the 'Pilot Monitoring' (PM)...

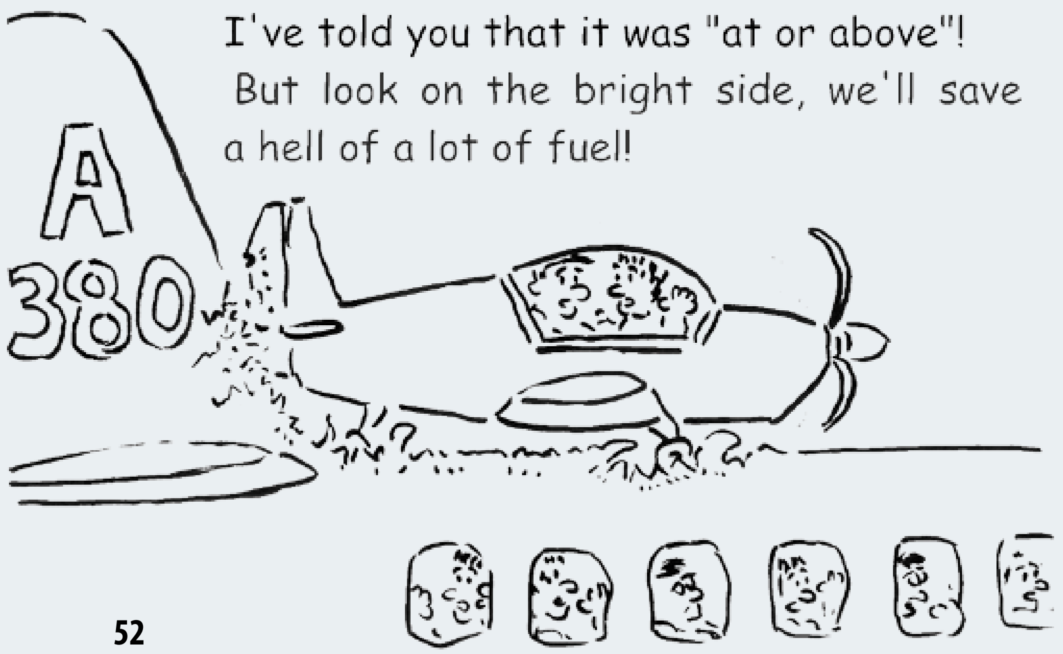
By HindSight Editorial Staff

Just to remind everyone, the PM used to be called the 'Pilot Not Flying' (PNF) and this designation may still be found. However, it was considered that this term was both negative (what does he do!) and also ignored the most important part of the PM role, which is to oversee (or monitor) the successful management of the flight without having to also focus primarily on the control of the aircraft.

However the cleared altitude is set, the 'Selected Altitude' should always show the current cleared altitude or level. And since most aircraft are flown most of the time through an Autopilot (AP) and not by the Pilot 'manually', whatever is set as the selected altitude will be what happens provided that it is either 'Armed' (the aircraft is on the way to a new vertical clearance) or 'Locked On' (the aircraft has captured the set altitude/level and the aircraft is being operated in an AP Mode which takes this set altitude/level as a controlling input (the usual case)).

Now we can look at how the cleared altitude is usually set – whilst remembering that the exact method will always depend on the SOPs of the aircraft operator. The important point is how the setting and checking of the cleared altitude is achieved. The first setting will be on the ground prior to take off. The PF will have led an interactive brief with the PM on the initial departure route which in most cases will be an SID with vertical as well as lateral requirements pre-defined and with the initial vertical clearance therefore carefully set by the PF and cross-checked by the PNF. Subsequent en route vertical clearances will be heard by both the PF and the PM and are then set by the PF and cross-checked by the PM, who must also read back the clearance to ATC and may still be required to write it down too whether or not this is a useful action at the time.

The precise order in which the PM carries out their tasks at each airborne re-clearance may vary. Usually, the PF will reset the cleared altitude/level straight away which will allow the PM to read back the clearance to ATC by reference to this revised setting having cross-checked the action of the PF. Sometimes, the PF will not be so quick to reset, so the re-clearance will be written down and acknowledged to ATC by the PM before it has been entered. The order in which the PM writes down and acknowledges a re-clearance as well as where the setting of the new altitude/level by the PF fits in to this is often the origin of a difference between what is read back and what is eventually set. Some operators will permit the PM to set a new cleared altitude on receipt provided that a positive confirmation



that the correct action has been taken is obtained from the PF as soon as practicable and it has been suggested that this method can reduce the occurrence of differences between what is said and what is done since at least the primary actions of setting and acknowledging are taken by the same person.

One of the real weaknesses in the shared roles of the PF and the PM is when either one of them is not listening out on the ATC frequency. Most operators now require that the main ATC frequency is monitored when airborne without simultaneous selection of other radio or intercom channels so that such monitoring is effective (although an exception may be made for monitoring of 121.5). This means that cabin crew communications, passenger public address, reception of ATIS data and company/handling agent communications require that the pilot involved leaves the main ATC frequency to the other pilot for short periods. Typical SOPs require that a return to the main frequency after such tasks is accompanied by an 'update'. But of course there has been no cross-checking during the period of absence.

And finally, some operator SOPs for the setting of cleared altitude are just not as rigorously specified as others and even if they are, and taking the normal case when both pilots are listening to ATC, those pilots, like everyone else, don't always do what they are supposed to do, intended to do or thought they were doing... ■

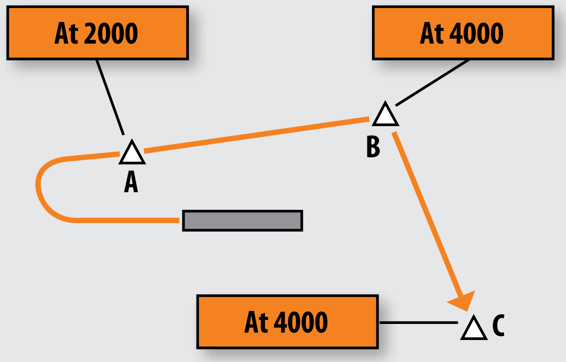
Are we cleared flight level 100?

A major airport somewhere in Europe. It is a nice sunny morning. The pre-flight preparations have been completed. All the passengers are on board and the cabin is clear for departure.

The flight crew is feeding the navigation computers and crosschecking the data with the ATC clearance which they have just received.

The clearance is on a Standard Instrument Departure (SID) route which includes several intermediate altitude restrictions.

By Captain Pascal Kremer, Luxair ▸



Pascal Kremer

is working for Luxair as Deputy Flight Safety Officer.
He is a former captain on the Embraer 145.
He is a certified accident and incident investigator and the Chairman of the ERA ASWG (European Regional Airlines Association Air Safety Workgroup).

After a short taxi time the aircraft is ready for take off. The crew is preparing for one of the most work-intensive parts of the flight. Both crew members mentally review the departure procedure.

> ***"Flight 123, cleared for take off runway 27, wind 270 at 5.***
> ***Contact departure when airborne. Goodbye."***
> ***"Flight 123 cleared take off. Goodbye."***

The captain advances the thrust levers. The aircraft accelerates down the runway. "V1, rotate." A gentle pull on the control column helps the aircraft leave the ground. The flight is on its way.

> ***"Departure, good morning, Flight 123 passing point A at 2000 feet"***
> ***"Flight 123, good morning, climb flight level 100."***
> ***"Climb flight level 100, Flight 123."***

The crew select flight level 100 on their instruments and start to climb. A few minutes later the ATC controller switches them over to the next frequency. Flight 123 is now cleared to climb to its final cruising level. After an uneventful flight the aircraft touches down at its destination.

A normal flight? Well, maybe not…Two years ago, the procedures for vertical clearance restrictions specified in ICAO Doc 4444, PANS-ATM, were altered by the issue of Amendment 5. The revised procedures state that:

> **"When a departing aircraft on a SID is cleared to climb to a level higher than the initially cleared level or the level(s) specified in a SID, the aircraft shall follow the published vertical profile of a SID, unless such restrictions are explicitly cancelled by ATC." and require the use of phraseology in the form:**
>
> ***CLIMB TO (level) [LEVEL RESTRICTION(S) (SID designator) CANCELLED***
> ***(or)***
> ***LEVEL RESTRICTION(S) (SID designator) AT (point) CANCELLED]***

The same applies for a Standard Instrument Arrival (STAR):

> **"When an arriving aircraft on a STAR is cleared to descend to a level lower than the level or the level(s) specified in a STAR, the aircraft shall follow the published vertical profile of a STAR, unless such restrictions are explicitly cancelled by ATC. Published minimum levels based on terrain clearance shall always be applied" and require the use of similar phraseology in the form:**
>
> ***DESCEND TO (level) [LEVEL RESTRICTION(S) (STAR designator) CANCELLED***
> ***(or)***
> ***LEVEL RESTRICTION(S) (STAR designator) AT (point) CANCELLED]***

So if ICAO procedures were being used, in the example given above the correct course of action would have been to respect the altitude restrictions of the SID until point C and only then begin the climb to flight level 100. And if in any doubt seek clarification from the ATC controller that the climb clearance cancelled the SID restrictions.

A discussion during a pilot safety refresher course highlighted the potential for level busts in these situations. In the example given, the pilot did not clarify the climb clearance with the ATC controller because he "had done so on previous flights and they always want you to start the climb straight away".

Unfortunately, before this change in PANS-ATM, the procedures for ATC ad-hoc vertical clearances following an initial SID or STAR clearance were the same as for any other vertical re-clearance. A new clearance cancelled all previous intermediate level restrictions unless they were specifically restated. But afterwards, the procedure for SID/STAR became different and most - but not all - European civil aviation authorities adopted the change and published it in their national AIP.

So back to the pilot's point of view. This change makes matters more complicated than they were before. Even worse, a State with some of the busiest airspace in Europe, the United Kingdom, has not adopted the change, and has published a difference in their AIP which retains the previous procedures under which an ATC re-clearance after an initial SID/STAR is exactly the same as any other re-clearance: There are no intermediate restrictions unless they are stated or re-stated upon re-clearance.

This would be difficult enough if ATC in the majority of States which have adopted the change always applied the new procedure strictly. But our pilot discussion suggested that this was not always the case, with many variations in the actual phraseology being used which sometimes left doubt in the pilots' minds as to whether or not a re-clearance of a SID/STAR involved continued intermediate restrictions. Add more difficulties such as bad weather, congested airspace, busy frequencies, non-native English-speaking pilots, technical difficulties, complacency or high workload to the cocktail and everybody in the discussion would agree that the way is open for a level bust and maybe worse.

So, since the safe option for pilots in any doubt as to possible restrictions on their ATC re-clearance is to request clarification from ATC, many more of these requests from pilots should be expected until:

- All European States operate the same procedures for re-clearance of initial SIDs and STARs, and
- ATC more carefully apply whichever phraseology for these re-clearances their State has decided to use

At least this way, it may be possible to prevent an increase in the risk of level busts from this cause until there is a better solution.

And by the way, the example used at the beginning of the article was taken from the UK, so our crew did have a normal flight after all….

SOME UK CAA COMMENTS – THE RATIONALE FOR FILING A DIFFERENCE WITH ICAO…

Pending the outcome of an ICAO review into this subject, UK procedures (AIC Y 048/2009 and the UK AIP GEN 1-7-48) state that for all stages of flight, instructions to climb or descend cancel any previous restrictions, unless these are reiterated as part of the later instruction. Additionally for aircraft on an SID, the word 'now' is added to climb clearances above the SID profile.

In considering the ICAO procedures and potential options, the UK CAA undertook extensive analysis of the international dimension, safety risks and human factors considerations concerning both flight crew and controllers, which identified a number of concerns.

- The revised PANS-ATM procedures for SID/STAR introduced an opposing convention to other stages of flight and a consequent need for flight crews to assess which phase of flight they are in so as to apply the correct convention.
- The revised procedures introduced a form of 'conditional' clearance but without the relevant conditions being explicitly stated on RTF.
- From a human factors perspective, there is a high likelihood of unintentional flight crew non-compliance. Such misunderstanding would result in an incorrect immediate climb or descent, and consequent level bust, which in busy TMA airspace has significant potential to be safety-critical.

The UK CAA continues to work both in Europe and ICAO towards a satisfactory resolution. In the meantime, the UK CAA guidance to UK pilots is that in the case of any doubt about the intention of a clearance, pilots should request clarification from ATC. If doubt arises when airborne, the safest course of action would be to continue to follow the SID/STAR profile while seeking clarification. ■

Another tool in the kit

by Max Bezzina

In a TMA somewhere in Europe:

Approach: "Tango X-ray Yankee zero five tree, descend to flight level eight zero."
TXY053: "Roger, descending to flight level eight zero, Tango X-ray Yankee zero five tree."

After a while as the controller observes the Mode C of TXY053 passing FL79 and descending:
Approach: "Tango X-ray Yankee zero five tree confirm maintaining flight level eight zero, traffic in the holding stack at your seven o'clock one thousand feet below your cleared flight level."
TXY053: "TCAS RA, Tango X-ray Yankee zero five tree."

Around the same time in another TMA not so far away from the first:

Approach: "Victor Zulu Alpha seven seven six, descend to flight level eight zero."
VZA776: "Roger, descending to flight level eight zero, Victor Zulu Alpha seven seven six."

After a moment, when the VZA was still passing FL100 in the descent, the controller checks the vertical stack list and notices that the aircraft selected flight level, as input by the pilot, is FL 60.
Approach: "Victor Zulu Alpha seven seven six, check selected level.
Cleared level is flight level eight zero."
VZA776: "Eeeh, Roger, stopping descent at flight level eight zero, Victor Zulu Alpha seven seven six.

There are several reasons why a level bust can happen, and some of the other articles in this issue of HindSight either talk directly about these, or recount situations where level busts (nearly) happened and then analyse some of the reasons why they did with the aim of learning for the future.

Likewise, there are several ways for us in the aviation community to prevent level busts from happening and (when they happen anyhow) to help us to recover as quickly as possible and avoid a dangerous situation developing.

It is worth mentioning some of the items in our tool kit for prevention and recovery:

- The proper definition of design and procedures governing the airspace.
- The ATC and aircraft operator's standard operating procedures.
- Radio discipline and appropriate phraseology.
- Training and awareness of the issue.
- Team work, vigilance and situational awareness.

In the VZA case above, we saw yet another tool in the kit that can assist with the prevention - the display at the controller's position of the downlinked selected flight level set on board the aircraft.

This is possible when the air traffic control system in use supports the processing and display of Mode S enhanced surveillance (EHS) and more specifically of the downlink aircraft parameter [DAP] – Selected Flight Level / Altitude (SFL or ALT SEL). Now, I am not an engineer, so I'll stop with the technical description while (I think) I am still on top! However, I decided to try and find out whether the display of Mode S EHS SFL actually helps reduce level busts and I discovered the following:

The European Action Plan for the prevention of level busts, dated July 2004, asks air navigation service providers [ANSPs] to consider the introduction of Mode S Selected Altitude display. I found that only two or possibly three European ANSPs have actually introduced this but that all of them reported a significant (in some cases of the order of 25%) decrease in level busts following the implementation.

Also, I found that in general, the controllers working with systems where Mode S SFL is adequately displayed at their working position are happy with this feature and feel that it is of major benefit to safety.

I then asked IFATCA if they had any concerns about the introduction of an SFL display to controllers and I was told that they had nothing against SFL display but that before implementing such a system an ANSP should study its implications for the system and the controller in a holistic way. Issues considered should include:

- The best way to display the data to controllers.
- Prioritisation between warnings (STCA, TCAS, APW, route deviation, etc. etc.) so as to avoid data overload and any conflict between alerts, warnings and systems

Max Bezinna

is currently working on EUROCONTROL's project and programme performance monitoring.

After finishing training, he spent the first 7 years of his ATC career as ATCO at Maastricht UAC. He then moved into ATC continuation training and was also Eurocontrol's team leader for e-learning.

Max has many interests. Relating to ATC he is particularly interested in the role of the human within the broader ATM system.

- Legal responsibility issues such as what is the status of the information presented (operational, trial or for information only?) and what are the consequences of using, or not using, such information.
- Ensuring that controllers appreciate that the SFL function displays intent-based information and that there may be circumstances when an aircraft will not fly to its selected level such as when it is being flown manually or when an incorrect altimeter sub-scale setting has been used in the cockpit.

There are many reasons why level busts can occur. There are equally many ways in which the ATC and the flying communities can prevent them from happening.

In one specific implementation about which I was informed, all the potential technical and operational issues described above seem to have been addressed. The ANSP in question also sought to clarify that, in terms of legal responsibility, the checking of the SFL display was not mandatory but that it was encouraged as an additional way to prompt early prevention of possible level busts. This ANSP also provided detailed briefings to the controllers on the policy and on the tools which were being introduced. As a result, Enhanced Mode S was well received and has provided significant safety benefits by reducing the incidence of level busts, which had previously been identified as one of their major safety risks.

So, if we have good examples of implementations which contribute to significant reductions in the occurrence of level busts, why is this technology not in more widespread use? Certainly, EHS capability cannot appear on all aircraft straight away and there are bound to be significant costs for an ANSP to install such a system. Within the scope of this article, I chose not to investigate further the reasons behind the lack of implementation. However, what is important to note is that we already have enough operational evidence to show that the properly-implemented display of SFL for controllers can significantly reduce level busts.

In conclusion, there are many reasons why level busts can occur. There are equally many ways in which the ATC and the flying communities can prevent them from happening. Most of these measures are complimentary and the use of one should not exclude the other. Now we have another: the real-time display of aircraft selected flight level to the controller. It is not the panacea for level bust, but could be another significant means of prevention. In my opinion controllers should lobby for its installation in their working environment and ANSPs should endeavour to install it appropriately as quickly as possible. Safety is at stake.

Editorial comment

Max quite rightly recommends that we add this tool to our level bust prevention kit. He also mentions most of the issues that will need to be addressed before it can be successfully introduced.

Max also stresses that the Mode S EHS SFL is a representation only of apparent flight crew **intent** – which of course is why it must not be used as a basis for separation, but as a valuable 'early warning system'. The procedure for use of SFL must be 'fail safe' and must recognise that such downlinked aircraft intent cannot be regarded as 100% accurate.

But we are reminded that the use of SFL data is already proving beneficial in reducing level busts despite the fact that it is not provided by all aircraft. You can benefit from the experience of the pioneers, so what are you waiting for?! ■

SKYbrary downloads

If you need to find out something about aviation safety, we suggest you go first to **www.skybrary.aero**. It doesn't matter whether you are a controller, a pilot or a maintenance engineer, SKYbrary aims to have either the answer you are looking for or a direct route to it.

SKY brary

If by any chance you can't find what you want, please remember that **SKYbrary** is a dynamic work-in-progress which needs continuous user feedback and benefits from user support. Be sure to tell the **SKYbrary Editor** about any difficulty you may have had making it work for you. If you can directly help us by identifying material we could use or even fill a gap by writing some content yourself then please tell us too!

We aim to provide wide coverage through both original articles and, especially, by hosting the best of what's already been written so that a wider audience can access it more easily in one place.

SKYbrary is also the place where you can access:

- all the documents of the **Flight Safety Foundation Operator's Guide to Human Factors in Aviation**
- the largest collection of selected official **accident & serious incident reports** from around the world anywhere in one place online
- an expanding facility to **search ICAO document text.**

In future, we will be reprinting a **SKYbrary** article in each issue of **HINDSIGHT**. This time we have chosen something which can affect us all – **Altimeter Setting Procedures**.

Altimeter Setting Procedures

Description

The aircraft **altimeter** barometric sub-scale must be set to the **appropriate setting** for the phase of flight. These are:

- **Flight level.** Standard pressure setting (1013 hPa) is set when flying by reference to flight levels above the transition altitude;
- **Altitude.** Regional or airfield pressure setting (QNH) is set when flying by reference to altitude above mean sea level below the transition level;
- **Height.** Altimeter pressure setting indicating height above airfield or touchdown (QFE) is set when approaching to land at an airfield where this procedure is in use.

Failure to set the appropriate barometric sub-scale pressure setting may result in a significant deviation from the cleared altitude or flight level.

Article Information

Category: Level Bust

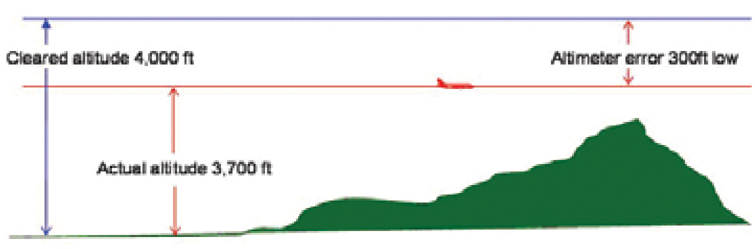
Content source: SKYbrary

Content source: EUROCONTROL

Types of Altimeter Setting Error:

- The pilot mishears the transmitted pressure setting and sets an incorrect figure.
- The pilot hears the transmitted pressure setting correctly but fails to set it or mis-sets it.
- The pilot fails to change the pressure setting at the appropriate point in a departure, climb, descent or approach.

Aircraft is cleared to fly at 4,000 ft QNH 1003 hPa.
Pilot forgets to set QNH and descends to 4,000 ft with 1013 hPa set.



The effect of a 10 hPa high altimeter setting

SKYbrary

Effects

- Failure to set the appropriate pressure setting can result in deviation from the cleared altitude or flight level, leading to level bust, loss of separation from other traffic, and even collision with other aircraft or with the ground (CFIT).
- Loss of situational awareness due to failure to appreciate the significance of a pressure setting (especially QFE as opposed to QNH). This can result in incorrect appreciation of the closeness of the ground possibly leading to an unstabilised approach or collision with the ground (CFIT).

Defences

Effective SOPs contained in company flight operations manuals which specify appropriate procedures for the setting and cross-checking of altimeter barometric sub-scales.

Typical Scenarios

- A pilot fails to ensure that standard pressure is set when passing the transition altitude in the climb, and levels the aircraft at a flight level which differs from the cleared level by an amount depending on the difference between the QNH and 1013 hPa.
- A pilot fails to set QNH when passing the transition level in the descent and levels the aircraft at an altitude which differs from the cleared altitude by an amount depending on the difference between QNH and 1013 hPa.
- A pilot unused to landing with QFE set does not remember that the altimeter now indicates height above airfield elevation or touch-down and consequently that the aircraft is likely to be closer, and possibly a lot closer, to the ground than with QNH set.

Solutions

- The existence of appropriate SOPs for the setting and cross-checking of altimeter sub-scales and their strict observance is the only universal primary solution to eliminate incorrect altimeter setting.
- Use of the aircraft radio altimeter to monitor the aircraft proximity with the ground can help to improve situational awareness provided that the flight crew are generally familiar with the terrain over which they are flying;
- GPWS/TAWS provide a safety net against CFIT and in the case of TAWS Class 'A' with its option of a simple terrain mapping display, it can also be used to directly improve routine situational awareness.

Related Articles

- Altimeter Pressure Settings

Further Reading

ICAO

- Doc 8168 (PANS-OPS), Volume I, Flight Procedures – Part VI – Altimeter Setting Procedures – Chapter 3.
- ICAO Video: Altimetry – Basic Principles;

EUROCONTROL Level Bust Toolkit

- Level Bust Briefing Note Ops 2 - Altimeter Setting Procedures;

Airbus Briefing Notes

- Airbus Supplementary Briefing Note - Altimeter Setting - Use of Radio Altimeter.

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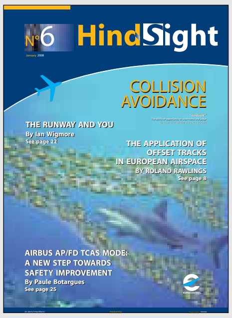

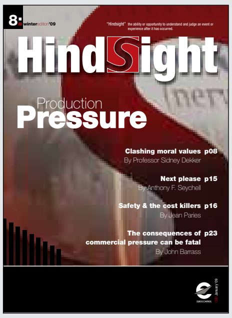

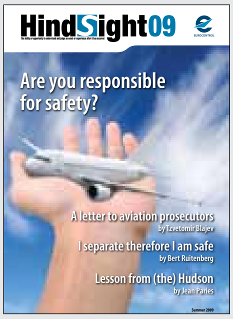

Next HindSight issue: Airspace Infringement

EUROCONTROL

Putting Safety First in Air Traffic Management

This publication has been prepared by the Safety Improvement Sub-Group (SISG) of EUROCONTROL. The Editor in Chief acknowledges the assistance given by many sources in its preparation.