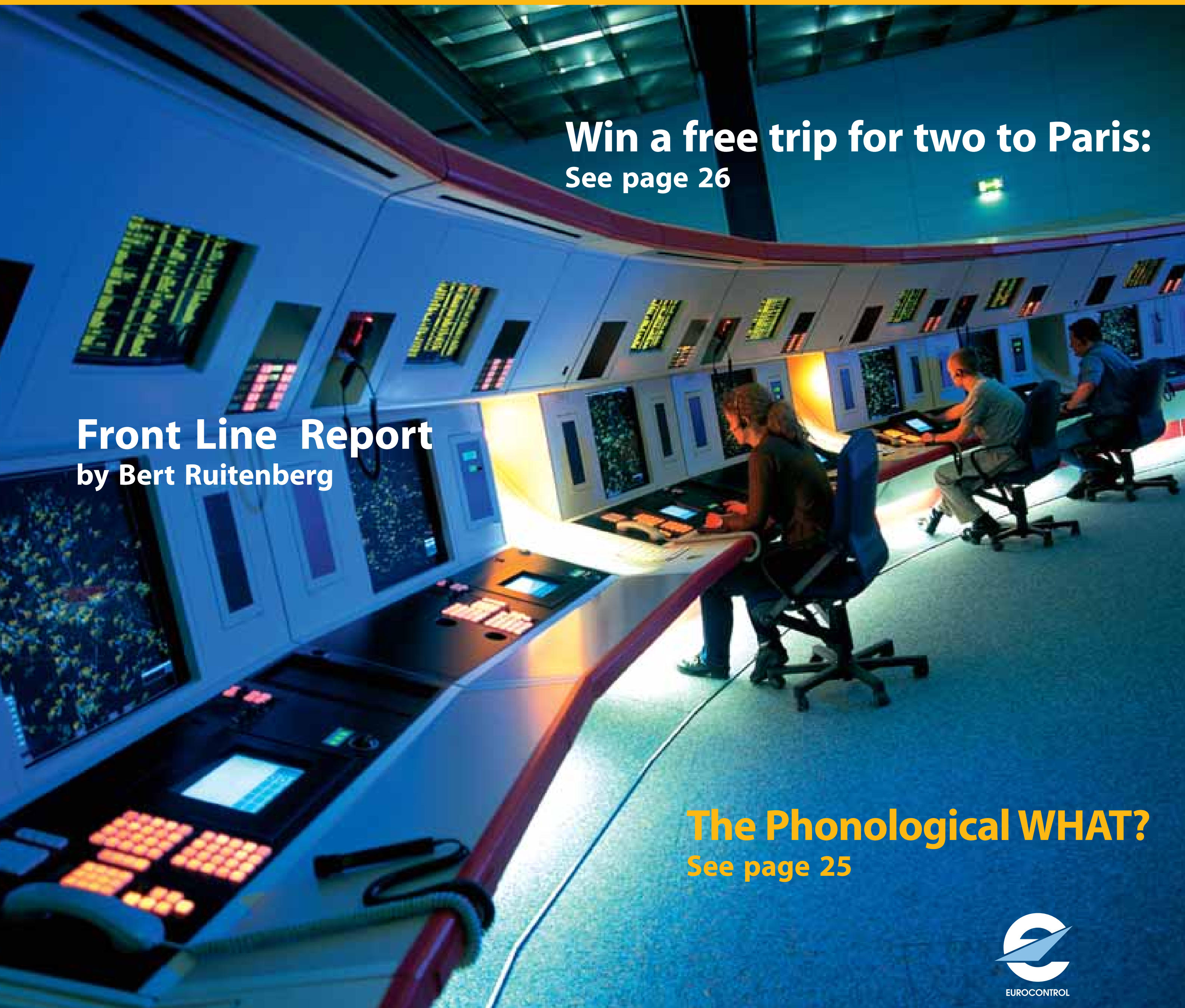
N°2
January 2006

HindSight

COMMUNICATION

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



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COMMUNICATION

By Tzvetomir Blajev
Co-ordinator Safety Inprovement Initiatives
and Editor in Chief of HindSight

"I communicate hence I exist" - this might not be exactly the same as the famous formula of Rene Descartes, but it very well reflects the nature of air traffic control.

Indeed air-ground communications serve as the main media for co-ordinating intentions and delivering instructions and important information. More than that - voice communication is currently the main mitigation against its own failures. This is the read-back / hear-back / confirmation process.

Losing something one normally has really makes you appreciate it. **Losing air-ground communications shows how critical it is for aviation safety.** But the hazardous scenarios in communications are not restricted only to the loss of communications - there is also call sign confusions, hearing what we expect to hear, undetected simultaneous transmissions, meaning different things by one and the same phrases, to name but a few.

There are fewer "safety nets" available after the communication is complete and therefore, not surprisingly, when the communication fails the outcome is very often a serious incident or an accident. This is also one of the reasons why, based on statistics, communication is very often found to be one of the contributors to safety occurrences. **Yet recent studies show that communication is a very reliable process, functioning thousands of times perfectly, correcting itself most of the time, but when it fails it "hurts".**

The road to improving safety in ATM, therefore, definitely passes through the area of air-ground communications safety. There is little to be gained by simply trying to make the current, already very reliable, processes more reliable. There is no point in simply repeating to the practitioners that they must be more careful with the hear-back process - their current performance is already exceeding the normal human reliability of hearing correctly. The solutions that need to addressed are in the area of formulating extra protection.

In 2004, in trying to protect this major "Achilles Heel" of the current air traffic control system, EUROCONTROL Safety Enhancement Business Division started a number of activities. **A series of briefing notes is in the course of preparation; a workshop on the subject was held in Brussels during September; and a fully developed toolkit will become available in 2007.**

This second edition of HindSight builds on the success of the first edition and the many useful comments made by you, the users, following its publication last year. Its content is broadly similar to the first edition, but there is a definite bias towards discussion of aspects of communication in this issue. HindSight highlights many valuable learning points; we hope that you will select those points which are particularly relevant to your organisation and give them wide circulation.

Most of all, we hope that you will enjoy reading HindSight; that you will find it useful; and that you, in your turn, will communicate to us your comments and experiences so that the next edition will be even better.

ABOUT HINDSIGHT

The main function of the *HindSight* magazine is to help operational air traffic controllers to share in the experiences of other controllers who have been involved in ATM-related safety occurrences. In this way, they will have an opportunity to broaden their experience of the problems that may be encountered; to consider the available solutions; and so to be better prepared should they meet similar occurrences themselves.

Material contained in *HindSight* falls into three distinct classes:

- Editorial
- 121.5 - Safety Alerts and
- The Briefing Room - Learning from Experience.

On page 2, you will find a table of contents listing articles under these three headings. Editorial material, such as this article, needs no explanation but a few words on the other two classes may prevent any misunderstanding.

121.5 Safety Alerts

From time to time EUROCONTROL issues Early Warning Messages and Safety Reminder Messages to draw the attention of the ATM community to emerging safety issues. The messages are intended to encourage discussion on the prevalence and seriousness of the issue and on the most appropriate reaction to them. Summaries of some recent messages are included.

The Briefing Room - Learning From Experience

The majority of *HindSight* is taken up with articles concentrating on specific safety issues. These usually comprise a study of an actual accident or incident(s) together with a summary of lessons learned. These articles are coded to reflect the subject material.

Some incidents relate to the performance of ATCOs or the ATM system, while others illustrate pilot errors which can arise from incorrect interpretation of ATC instructions, or other unpredictable situations.

The incidents fall into two categories:

- **Summaries of accident and serious incident reports**

The full report usually runs to many pages, so these reports must be summarised and simplified, concentrating on the ATM-related aspects and passing quickly over (or even ignoring) other issues which have no direct relevance to ATCOs. A reference to the original report is always supplied.

- **Dis-identified accounts of other ATM-related incidents**

Typically, the original reports are not in the public domain; however there are important lessons to be learned from them. The identifying features of the reports are altered without changing the substance of the reports in order to preserve the confidentiality of the reporter.

Lessons Learned

In the articles that follow, only the lessons learned from the featured accidents and incidents are listed. Posters listing all relevant learning points are in the course of preparation.

Knowledge Base

We intend to compile a Knowledge Base of all types of ATM-related safety reports, which may be accessed by persons carrying out research on particular subjects. This is a long-term project but we plan that the HindSight magazine should be integrated with it from the outset.

Coding of Subject Matter

To aid identification of subject matter, each article is coded and marked by a coloured icon which appears at its head.

FRONT LINE REPORT GETTING THE MESSAGE ACROSS

by Bert Ruitenberg

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.

It happened in the early hours of what promised to become another fine summer's day. A twin propeller commuter flight was just beginning to taxi to the departure runway, an activity that would take close to 10 minutes because of the remote location of the runway, when the tower controller realised that there was an opportunity to let this flight use the main landing runway for take-off since there were few inbounds at that moment.

The controller passed the offer to use the nearby runway to the commuter's crew, duly using standard ICAO phraseology of course, and the crew was only too happy to accept this option for it meant a saving of some 10 minutes of taxi time. When the crew reported ready for departure at the assigned intersection near the middle of the runway, the controller gave the take-off clearance and again duly included the runway designator in his call. Now try to imagine the controller's surprise when he saw the aircraft accelerate on the runway in the opposite direction of what had been correctly acknowledged by the crew several times when accepting the offer and when reading back their take-off clearance…

When analysing this event - hang on! Before I go there you probably want to know the outcome of the event, right? Well, the controller considered instructing the aircraft to stop its take-off roll but since the first inbound aircraft was still far enough away from the runway he decided to just let the rolling aircraft continue its take-off, and resolve the situation in the air. The commuter was turned away from the centreline once airborne, so the path of the inbound aircraft was clear by the time the ILS was intercepted. A short but interesting discussion followed with the crew of the commuter aircraft, about topics such as compass headings and runway directions, and suffice it to say that the content of ICAO approved phraseology in that discussion was less than average.

What may have played a role in the event is that although it is perfectly legal and within published procedures to use the runway for departures in the direction assigned to the commuter, most departures from that runway are done in the opposite direction (with landings then obviously taking place on another runway). The point of this story however is to demonstrate that serious communication errors can occur even when perfect ICAO phraseology is used by both the controller and the pilots.

This is why I'm not terribly impressed with some of the draft recommendations that were proposed in the Air Ground Communications workshop that was held at the Eurocontrol headquarters in Brussels on 30 September 2005. In particular I'm referring to those recommendations that say things like "use standard phraseology", "take extra care where language difficulties could exist" and "always listen carefully to readbacks".

Don't get me wrong, I don't question that the advice contained in these recommendations is sound. It's just that I think that the practical value of giving that advice to seasoned aviation professionals is about the same as when telling car drivers to "drive carefully" in the hope that the number of road traffic accidents will go down, i.e. the value is little to zero. If these or similar recommendations are the best the industry can come up with to resolve air-ground communication problems, we've not come very far since the radio was invented by Marconi over a century ago.

Instead of addressing human behaviour I'd put my money on other draft recommendations, that were also discussed in the workshop, like the systemic deconflicting of similar call signs, the use of data link, and the application of a technical device that would not just alert users that a simultaneous transmission takes place but that would prevent simultaneous transmissions altogether. (Where I suggest "data link" this is not meant to imply that it should replace voice communications. I'm a fan of data link as an extra means of air-ground communications. Send information by data link, and use voice for instructions - it can be as simple as that.)

Having said this, it is interesting to note how none of those proposed recommendations or solutions would have made any difference in the event described at the beginning of this text. In that event the problem wasn't the technique nor the technology used for the communication, rather it was the content and the related interpretation of the message that resulted in a take-off in the wrong direction.

Air Traffic Controllers are a service-oriented breed. When we see a possibility for a direct routing, a taxi shortcut or a more optimal runway we'll offer it to our customers. But I think we should start asking ourselves whether we really are doing the pilots a favour, or whether we're merely giving them an extra opportunity to make a mistake. I submit that in today's environment the potential gains of the former are often outweighed by the potential for risk in the latter.

Bert Ruitenberg

PS *- If you're familiar with the Threat and Error Management (TEM) framework that is being advocated by ICAO and other bodies, I recommend going over the event described above again from a TEM perspective to see what Threats, Errors and Undesired States can be identified from the ATC and the pilots' viewpoints. If you're not yet familiar with the TEM framework I recommend an internet search or a dedicated visit to the website of ICAO (http://www.icao.int/ANB/humanfactors/) where a text on TEM for ATC can be downloaded.*

COGNITIVE FIXATION

by Professor Sidney Dekker

Sidney Dekker is Professor of Human Factors & Aviation Safety at Lund University in Sweden. He gained his PhD 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".

People always think they know what is going on, what the world around them looks like. Of course, these ideas may be incomplete or even wrong (compared to what they discover the world to have been), but saying that something has been lost is not helpful. It is better to try to understand how this picture may have made sense, or felt complete or accurate, to people at the time.

Making sense of a situation, or "sensemaking", is an ongoing process. People's actions and assessments of what is going on are deeply intertwined. By doing something, people learn more about the world. This in turn helps them decide what to do next. The dynamics of sensemaking in unfolding situations can, however, create interesting side effects.

Some important aspects of sensemaking may arise, especially when controllers are faced with an unfamiliar or unexpected problem, for example:

- A well-formulated diagnosis of the problem is often impossible. Handbooks and checklist are of little help
- Controllers have to make provisional assessments of what is going on based on partial and uncertain data
- Controllers' situation assessment and corrective actions are tightly interwoven. One constrains and informs the other
- Taking action simplifies the diagnostic problem. It commits controllers to a particular interpretation
- A side effect of taking action is that controllers build an explanation that justifies their action. This explanation may persist and can get transformed into an assumption that is then taken for granted.

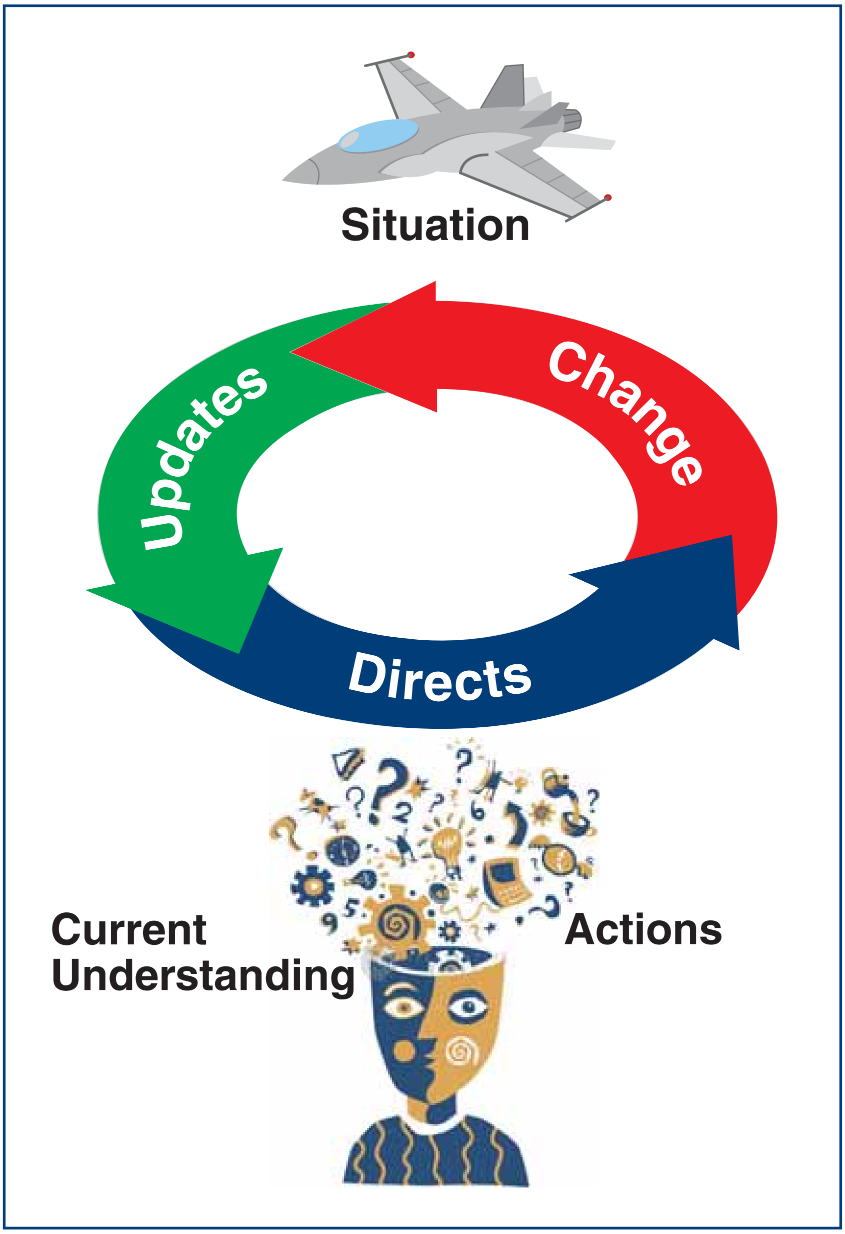
From an emerging mass of uncertain, incomplete and contradictory data, controllers have to come up with a plausible explanation. In this situation, their judgement may be biased in a particular direction (e.g."this is an indication problem"). A preliminary interpretation allows them to settle on at least a plausible explanation that covers the data observed. But it can activate certain kinds of knowledge and trouble-shooting activities at the expense of others.

The danger is that controllers might hold on to an assessment of a situation in spite of new contradictory evidence - psychologists call this "cognitive fixation". The assessment may actually be wrong in the first place, with more and more evidence contradicting the assessment coming in over time. Alternatively, the assessment, while initially right, can grow increasingly at odds with the way the situation is really developing.

Whether or not to abandon an initial interpretation has nothing to do with a controller's motivation. They are very interested in getting it right-in understanding what is going on. Instead, it is about a cognitive balancing act. When trying to understand and simultaneously manage a changing, uncertain situation the questions arise:

- Should you change your explanation of what is going on with every new piece of data that comes in? This is called "thematic vagabonding", a jumping around from explanation to explanation, driven by the loudest or latest indication or alarm. No coherent picture of what is going on can emerge
- Or should you keep your explanation stable despite newly emerging data that could suggest other plausible scenarios? Not revising your assessment (cognitive fixation) can lead to an obsolete understanding.

There is no right or wrong here. Only hindsight can show you whether controllers should have abandoned one explanation in favour of another, or should have finally settled on a stable interpretation instead of just pursuing the latest clue. To understand human performance from the point of view of the controller on the job, you have to acknowledge the existence and importance of this balancing act. Thematic vagabonding and getting cognitively locked up are opposite extremes, created by uncertain, dynamic situations in which we ask controllers to solve difficult, unclear problems.



121.5
SAFETY ALERTS

EARLY WARNING MESSAGE SUMMARY

CHANGES TO THE INDICATION OF VHF CHANNELS IN RADIOTELEPHONY

Origin: EUROCONTROL 8.33 kHz Programme Manager

Issued: 16 November 2005

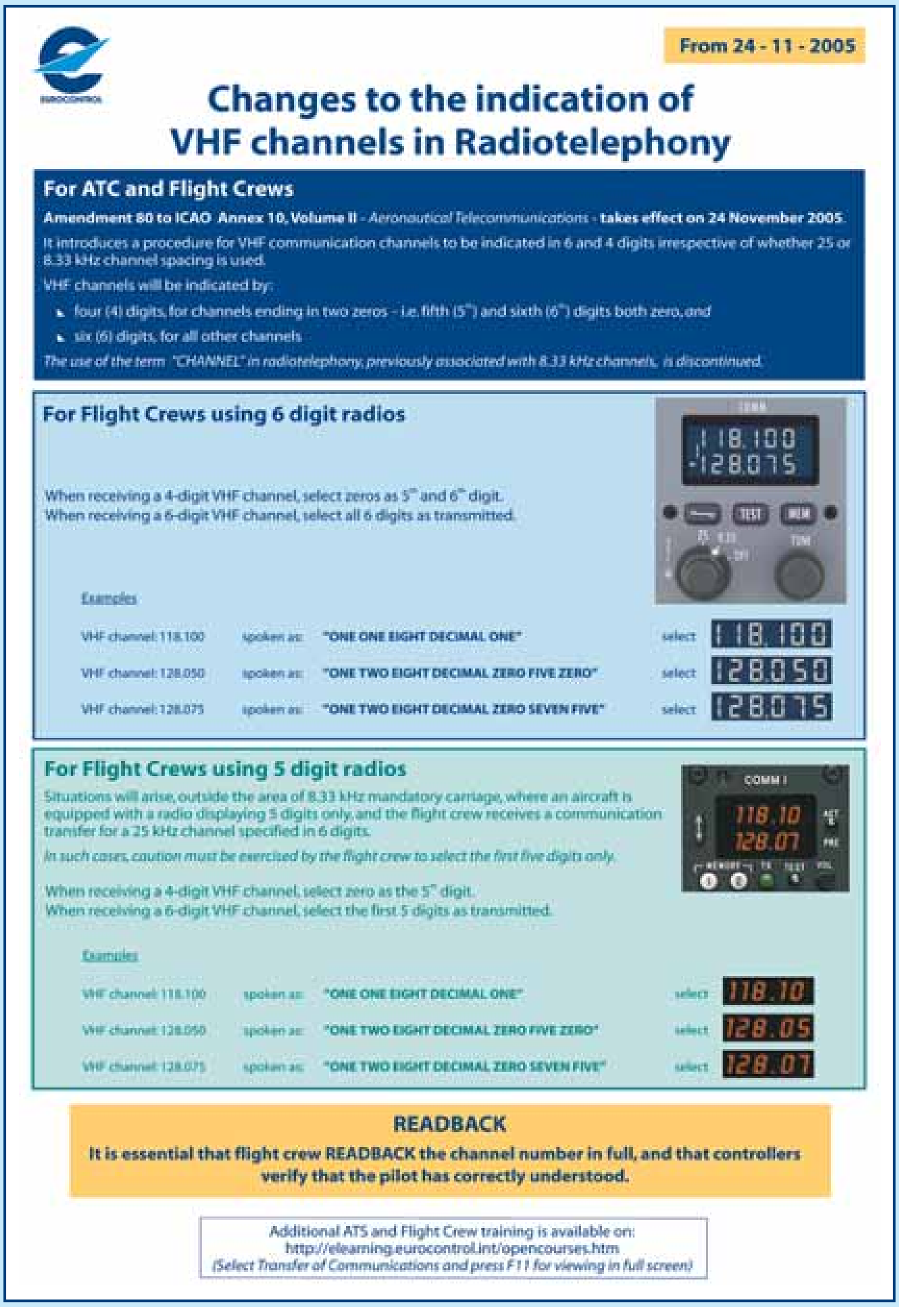
Changes to Procedures

Amendment 80 to ICAO Annex 10, Volume II - Aeronautical Telecommunications - takes effect on 24 November 2005;

- It introduces a procedure for VHF communication channels to be indicated in 6 and 4 digits irrespective of whether 25 or 8.33 kHz channel spacing is used, e.g
  - 118,005 specified as "ONE ONE EIGHT DECIMAL ZERO ZERO FIVE"
  - 118,025 specified as "ONE ONE EIGHT DECIMAL ZERO TWO FIVE"
  - 118,100 specified as "ONE ONE EIGHT DECIMAL ONE"
- Use of the term "CHANNEL" for 8.33 kHz channels is discontinued

EUROCONTROL 8.33 kHz Programme

- The EUROCONTROL Agency has prepared a poster to increase awareness on a revised procedure for the indication of VHF channels in radiotelephony
- The widespread distribution and display of this poster, especially to flight crews and air traffic controllers, is strongly encouraged
- Further information, and a copy of the poster, is available at http://www.eurocontrol.int/vhf833/public/standard_page/RTprocedures.html



EARLY WARNING MESSAGE SUMMARY:

INADVERTENT TRANSITION TO STANDBY MODE OF THE HONEYWELL PRIMUS II TRANSPONDER

Origin: Skyguide
Issued: 13 April 2005

The Problem

- The Swiss ANSP, Skyguide, has warned of several cases of radar track loss
- With the help of some airlines, it was discovered that an anomaly could exist due to an interface issue in the Honeywell Primus suite with Mode-S transponders. If the flight crew take longer than 5 seconds to complete a Mode-A code change, the transponder will revert to "Standby" mode. This will cause the track to be dropped by radars, and the TCAS II on board the aircraft will fail
- The operational consequences are high with a safety critical impact:
  - Temporary loss of radar contact
  - Degradation of the ACAS safety net - the aircraft's TCAS will fail, and the aircraft will not be acquired by other TCAS II equipped aircraft in the vicinity since the transponder is in "Standby" mode.

NOTE THAT THIS PROBLEM COULD OCCUR IN ALL AIRSPACE ENVIRONMENTS

Action Taken

- Skyguide took the following action:
  - Issue of company "Flash" note to the crew of the relevant airlines
  - Increase awareness of the Skyguide ATCO at Geneva and Zurich
  - Reminder to pilots by ATCOs in case of loss of radar contact
- Honeywell took the following action:
  - Honeywell Technical Newsletter (TNL) A23-1146-004 dated 9 December 2004 was issued. It was sent to every aircraft operator of Honeywell Primus equipment with Mode S transponders. The TNL recommends a temporary solution by means of an operational procedure for the flight crew to check, after every Mode-A code change, that the transponder has not reverted to "Standby" mode
  - A software change is being developed for release by Service Bulletin.

Recent Experience

- Incidents related to this problem which took place during April 2005 have shown that some flight crews are not aware of the operational procedure proposed in the Honeywell TNL
- EUROCONTROL Mode-S & ACAS Programme:
  - The Mode-S & ACAS Programme is pressing for effective enforcement action by Regulatory Authorities.

Action Required

- Increased vigilance is essential, to ensure that tracks are not dropped at times of Mode-A code change, pending rectification of this problem
- Any occurrences should be reported to the Eurocontrol MSA Airborne Monitoring Project (AMP) at modesanomaly@eurocontrol.int.

EARLY WARNING MESSAGE SUMMARY

SAFETY OCCURRENCES DURING ON-THE-JOB TRAINING

Origin: EUROCONTROL Agency
Issued: 20 September 2005

The Problem

- According to a recent report, 10% of the analysed safety occurrences are associated with the "controller under training" situation
- This fact alone does not give sufficient indication of the scale of the problem, unless statistics are made available to establish the relationship between the total number of sector hours and the number of sector/hours during on-the-job training (OJT) for a specified time period
- Independent of the above argument some ANSPs are concerned by an increasing trend in such events
- While "Lack of attention from the instructor" was reported as "infrequent to none" during the first 10 minutes of an OJT session, it was reported as "significant" during the second hour in working position.

Potential Explanations

- Insufficient awareness by the instructors of the level of competence of the student or trainee they are supervising
- The instructor allowing the situation to develop for the purpose of training
- Distraction of the instructor
- An unmanaged mismatch between simulator exercise timing (often between 45 minutes and 1 hour) and the time on the position (often 2 hours)
- General inconsistency between the ab-initio and OJT programmes in terms of:
    - Level of knowledge and skills required to start OJT
- General inconsistency between the simulator and OJT process in terms of:
    - Change of instructors
    - Change in system support provided by the simulator facility and the operational system
    - Specific operational environment not known to the needed level of detail
    - Unrealistic simulation environment, including aircraft performance and coordination procedures
- In general, humans are not good at monitoring tasks and the OJT instructor role demands a high degree of monitoring.

Potential Solutions

- The OJT instructor is responsible for the safety of the ATC service being provided under supervision. Therefore consider:
    - Identifying needs for and implement improvements in the selection and training of the OJT instructor
    - Clearly defining and documenting the roles and responsibilities of the OJT instructor and implementing them in the OJT instructor training programme
    - Limiting the time on the OJT position
    - Providing refresher training on coaching techniques and error recovery to OJT instructors on a regular basis
    - Introducing a regular meeting forum for the OJT instructors for exchanging lessons learned and good practices and for supporting drafting the respective Unit/ANSP Training Plan
    - Making arrangements for sharing situational awareness and the plan of work between the OJT instructor and the trainee
    - Detailing when and how to take over control from the trainee, including the take over of communication by using the appropriate switch/pedal to activate the transmitter
    - Detailing the procedure for the hand-over/take-over of the position, including introducing appropriate checklists
    - Ensuring the OJT instructor is briefed on the level of proficiency of the student/trainee
    - Developing a competence scheme for OJT instructors

- Ensure that the ANSP has a procedure to provide assurance that students and trainees are appropriately trained and licensed
- Consider limiting the number of permitted OJT instructors per trainee
- Consider restricting simultaneous OJT on more than one position of a sector or more than one adjacent sectors
- Consider incremental increase of complexity in the training programme - defining training phases and communicating the objectives and progress of the phase, including strong and weak points
- Consider introducing the practice of briefings and de-briefings between the OJT instructor and the trainee
- Review the training programmes to ensure that they reflect the knowledge and skills required for:
  - Collision avoidance
  - Emergency situations
- Ensure smooth transition from simulator to OJT, including:
  - Sufficient simulator time
  - Training in emergency and unusual situations
  - Identical system support
  - Simulation environment as close as possible to the operational environment
  - Consider the possibility for OJT instructor and student to be able to use simulation facilities during OJT so that certain experiences occurring with live traffic can be repeated in a simulated environment in order to maximise the lessons learned.

EARLY WARNING MESSAGE SUMMARY:

RATE OF CLIMB WITHIN LAST 1000FT BEFORE CLEARED LEVEL

Origin: Airline
Issued: 03 October 2005

The Problem

- In order to reduce the risk of ACAS/TCAS Resolution Advisories (RAs) which are subsequently shown to have been operationally unnecessary - so called "nuisance" RAs - many operators have standard operating procedures requiring pilots to reduce their rate of climb or descent to less than 1500ft/min when in RVSM airspace or within the last 1000ft before cleared level
- Some operators have expressed concern that when ATC controllers specify a rate of climb or descent, they expect the pilots to maintain the given rate until reaching the cleared altitude.

Factual Information

- RAs could occur when aircraft are in close proximity and the vertical speed of closure, which may be the sum of the vertical speeds of both aircraft or the vertical speed of just one aircraft, exceeds 1500ft/min
- Flight Crews can reduce the likelihood of an RA by confining vertical speeds to less than 1000ft/min, and ideally between 500 and 1000ft/min, within the last 1000ft before reaching assigned level. Many national authorities have issued recommendations to this effect within their flight rules and procedures
- ATC may request different rates of climb or descent at any time for the purpose of maintaining separation of aircraft. In such cases, these rates shall be strictly complied with. Failure to do so could result in a potentially serious loss of separation. It should not be supposed that there will "automatically" be an RA.

Potential Solutions

- Aircraft Operators will remind flight crews that, if able, they are expected to comply with ATC instructions regarding rates of climb and descent
- Controllers must be aware of the possibility of "nuisance" RAs when vertical speeds exceed 1500ft/min when approaching a cleared level and there are other aircraft in close proximity. (1500ft/min in itself does not mean that there will be an RA; it depends whether there are other aircraft in close proximity.)
- Of course, a high rate of climb or descent cannot be maintained right up to the cleared level or the aircraft will overshoot it!

LOSS OF SEPARATION

Reproduced with permission of the Direction des Opérations de la DSNA, BP 155, 94541 ORLY AEROGARE CEDEX in translation from the Bulletin Sécurité de la Circulation Aérienne N° 36.

A serious incident occurred following a misunderstanding in the course of telephone coordination. When the controllers discovered the conflict, they issued avoiding instructions; however, both aircraft received TCAS RAs instructing them to manoeuvre in the opposite direction. One of the two aircraft followed the controller's instruction, which was the opposite of the TCAS advisory, then belatedly manoeuvred in the manner requested by TCAS. This incident occurred between two centres with superimposed airspace: Paris controls airspace below FL 285 and Brest is responsible for airspace above that level.

Both centres knew about BAW 2486, which had taken off from London and was to be coordinated by Paris to climb to the airspace controlled by Brest. There was another Speedbird at FL 270, BAW 360, which was known and visible only to Paris; and lastly a DAL 27 at FL 290, known and visible only to Brest.

BAW 360 asked Paris if it could climb due to turbulence.

Brest could not see an aircraft, call sign 360

For the Paris radar controller, there was no ambiguity about which aircraft was the subject of the coordination. He commented afterwards, "Traffic was very quiet so I decided to coordinate this request myself. First of all I used the "Display" function for the Brest sector in order to help it identify the aircraft. I was unaware that this function depended on there being a flight plan in the Flight Plan Processing System of the receiving centre."

"Then I called Brest but before I could say anything, I heard, "*what about the Speedbird?*" I assumed that the Brest planning controller could see Speedbird 360 and therefore knew why I was calling. Nevertheless I confirmed, adding "360" and I explained why he wished to climb. I suggested the next highest odd flight level, FL 290, since the aircraft was bound for Lyon and was not expected to climb."

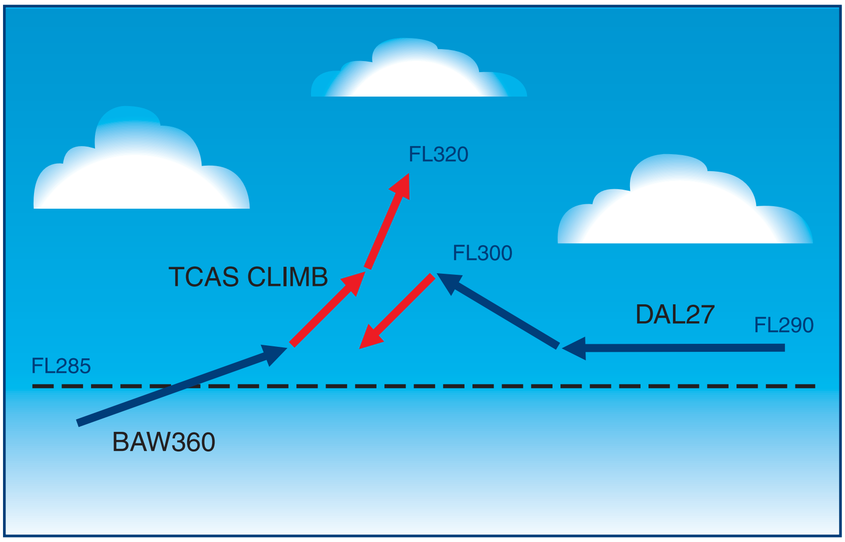
For this part, the Brest controller was expecting coordination for BAW 2486 and was certain he knew what the call was about. "I had in my hand the strip for BAW 2486 and was expecting a call from the Paris to suggest climb clearance. The button for Paris lit up and I said, "Is it for the Speedbird?""

"Paris replied: "Yes, three six zero". I thought that he was talking about a flight level, that BAW 2486 had asked for FL 360, or that he was answering someone else. I gave FL 290, thinking that we were talking about BAW 2486, but Paris took this level for BAW 360, for which I had neither a strip nor a display."

Paris - Hello?
Brest - What about the Speedbird?
Paris - 360 yes, he's above the clouds and it's getting rough apparently - he'd like to climb.
Brest - Yes, well, you can tell him to climb to…
Paris - 29?
Brest - Yep, 29 is fine.
Paris - OK, I'll make the "MOD" and send it to you.
Brest - OK, thanks.

The climb was about to cause a conflict with another aircraft

Two thousand feet above, DAL 27 was in level flight at FL 290. Only Brest was aware of this aircraft. BAW 360 climbed, having received clearance, and the corresponding "MOD" was made immediately, causing the aircraft to be displayed in the upper airspace (at Brest) and the safety net alert to be triggered. The two aircraft were at the same level, 10 nm apart, and converging.



Contradictory avoidance instructions and TCAS Resolution Advisories

Paris asked BAW 360 to descend again while at the same time Brest asked DAL 27 to climb to FL 300 (using emergency phraseology).

But BAW 360 announced that it was following a TCAS RA to climb. For its part the other aircraft climbed too, reaching FL 300, then belatedly follows the TCAS RA to descend. BAW 360 continued its climb to FL 320 at 4,500 ft/min, since the pilot was visual with the approaching aircraft. Minimum separation was measured at approximately 1nm and 100 ft.

Contributory causes and factors

The Local Safety Committee identified the cause of this incident as: "confusion between the radar controller for the Paris sector and the planning controller for Brest sector at the time of telephone coordination as regards which aircraft was the subject of the coordination."

The two controllers were talking at cross purposes and the exchanges on the telephone concerning "BAW" (360 for one controller and 2486 for the other) were not rigorous enough to enable the confusion to be resolved. Furthermore the fact that the "DISPLAY" seemed to be working properly no doubt reassured the Paris controller as regards the way he proposed coordination to the Brest controller.

Lessons Learned

- Controllers must be completely familiar with the limitations as well as the advantages of the technical equipment they operate
- To avoid misunderstanding, controllers must use full call signs and avoid short-cuts when arranging co-ordination with an adjacent sector
- Care must be taken when there is the possibility of confusion between two numbers, to ensure that, for example, a call sign is not mistaken for a level or a heading, or vice-versa

The EUROCONTROL Level Bust Toolkit contains further information to reduce the potential for loss of separation. The Toolkit may be obtained on CD ROM by contacting the Coordinator Safety Improvements Initiative, Mr Tzvetomir Blajev, on
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CONTROLLED FLIGHT INTO TERRAIN

In spite of years of concentrated effort by the aviation community, Controlled Flight into Terrain (CFIT) remains the No1 aviation killer. In most cases, CFIT accidents are caused primarily by the actions of the pilot, and there is little scope for ATC intervention. However, there have been instances where controller action - or inaction - has been the direct cause, or where action by the controller could have saved the day. The following report, based on the findings of the NTSB investigation[2], illustrates this point very well. The accident took place in USA, but perhaps it could have happened anywhere.

Factual Information

On 10th May 2004, at about 2051 local time, a Piper Seminole aircraft, N304PA, collided with mountainous terrain at Julian, California. The aircraft was operated by Pan Am

International Flight Academy. Both private pilots were fatally injured and the aircraft was destroyed. Visual meteorological conditions prevailed and an instrument flight plan had been filed. The flight originated at Deer Valley, Arizona.

The aircraft was on an IFR flight from Phoenix, Arizona, to Carlsbad, California. N304PA was number four in a train of five company aircrafts flying the same route. The time separation between each aircraft was about 5 to 10 minutes. The aircraft directly ahead of N304PA was N434PA.

The flight crew of N304PA contacted the San Diego North Radar (SDNR) controller at 2043:48, reporting level at 8,000. The SDNR controller instructed the pilot to fly heading 260 after Julian and intercept the (Palomar) localiser. The pilot read back the clearance.

At 2045:47, the SDNR controller told the pilot of N434PA, the Piper Seminole ahead of N304PA and flying the same route, to descend to 6,000 feet. The pilot of N434PA acknowledged the clearance.

At 2047:55, the SDNR controller transmitted, "Seminole four papa alpha descend and maintain five thousand two hundred." The pilot of N304PA responded, "Down to five thousand two hundred for three zero four papa alpha." According to information provided by the approach controller, this clearance was intended for N434PA. The controller did not recognize that the clearance had been acknowledged by N304PA rather than N434PA.

At 2048:19, the pilot of N434PA transmitted, "…for four three four papa alpha?" (The beginning of the transmission was blocked by another transmission from the SDNR controller to an uninvolved aircraft.) The SDNR controller replied, "No. Duke six romeo tango heading one nine zero maintain eight thousand."

When, at 2049:03, N304PA descended below 7,800 feet, the MSAW system activated and provided a visual alert to the controller. The alert continued until N304PA struck the terrain, although recorded automation data shows that the controller dropped the data block from the display when the aircraft descended through 6,800 feet.

At 2049:55, the pilot of N304PA reported that he had ATIS information Zulu at Palomar, and the SDNR controller responded, "Seminole three zero four papa alpha thank you very much." According to radar data, at that time N304PA was descending through about 6,600 feet.

At 2050:27, the SDNR controller again cleared N434PA to descend and maintain 5,200 feet. The pilot read back the clearance, and the SDNR controller then transmitted, "Seminole four three four papa alpha is five miles from ESCON. Cross ESCON three thousand five hundred or above cleared ILS 24 at Palomar." The pilot of N434PA acknowledged.

The TRACON's MSAW system generated two predicted altitude alerts on the accident aircraft at 2050:46 and 2050:51. According to FAA MSAW documentation, two consecutive predicted alerts will initiate an MSAW warning to the controller working the affected aircraft. Collectively, these alerts would have caused a 5 second aural alert to the sector controller beginning at 2050:51, along with a flashing red "LA" in N304PA's data block from 2050:51 until about 2051:06.

N304PA then descended below radar coverage and the alert terminated. The wreckage of N304PA was located on a ridgeline 200 yards south of the Julian VOR at 5,537 feet above sea level.

Accident Cause

The NTSB determined the cause of this accident to be the incorrect use of an abbreviated call sign by the sector controller when issuing of a descent clearance to N434PA, and the sector controller's failure to detect that the pilot of N304PA had read the clearance back with the full call sign.

[2] www.ntsb.gov/ntsb/query.asp

A contributing cause was the N304PA pilot's failure to question a clearance that put them below the published minimum en route altitude. Another contributing cause to the accident was the failure of both the Centre and TRACON controllers to properly respond to the aural and visual MSAW alert.

Analysis

The similarity of the aircraft call signs - N434PA and N304PA - meant that there was a high probability of confusion. However, if this danger was appreciated by the controllers involved, they did not point it out either to the pilots involved or to adjacent sector controllers.

This danger of call sign confusion was increased when the SDNR controller abbreviated the first aircraft's call sign "Seminole four papa alpha"; this abbreviated call sign could have applied equally to N304PA or N434PA. It is legitimate for an aircraft call sign of this type to be abbreviated "After satisfactory communication has been established… provided that no confusion is likely to arise[2]"; however, in this case, both aircraft had checked in on frequency and it should have been obvious to the controller that confusion was extremely likely to arise.

The pilot of N304PA may have understood that this risk existed, for he used the full call sign in his response "Down to five thousand two hundred for three zero four papa alpha"; however, by placing his call sign at the end of the message and preceding it by the word "for" (which may have been misunderstood as the figure "four") the chance of the controller detecting the mistake was reduced.

The missing words from the blocked transmission from N434PA at 2048:19 are not known, but given the timing of the message (immediately after N304PA wrongly accepted the other aircraft's descent clearance), it is quite probable that the full transmission was "was that descent clearance… for four three four papa alpha?" If the controller had asked N434PA to repeat his message he might have realised that the clearance had been taken by the wrong aircraft.

The necessity to repeat the descent clearance for N434PA two minutes after the first clearance, coupled with the height loss depicted on N304PA's data block and the MSAW alert should have alerted the SDNR controller to the impending accident, but appears to have overlooked all these clues took no action. The TRACON controller also received two MSAW alerts but apparently took no action either.

[3] See ICAO Annex 10 Volume II Section 5.2.1.7

Lessons Learned

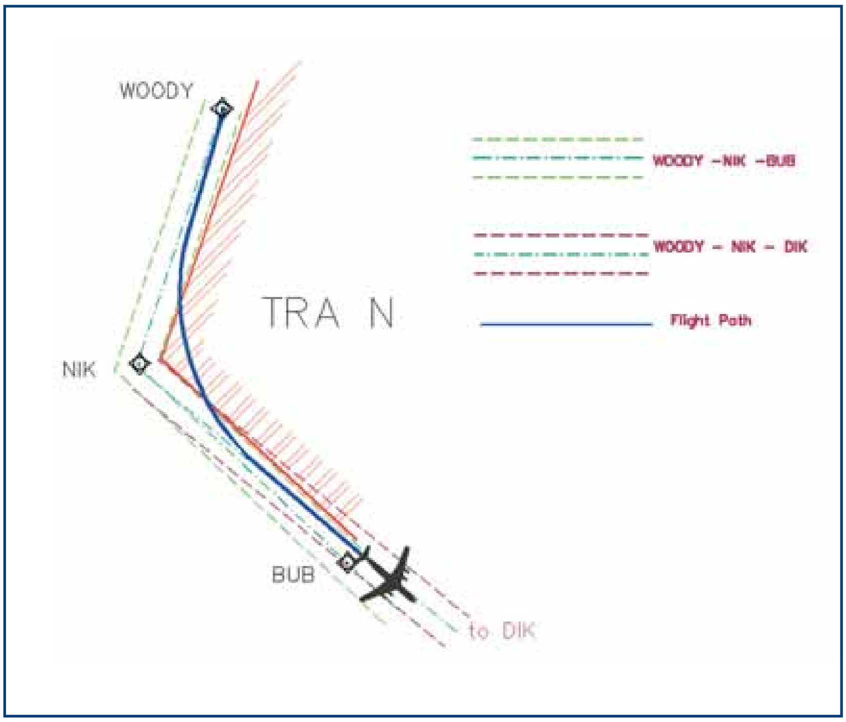
During the 1990s, international collaboration led by the Flight Safety Foundation (FSF) resulted in the development of the FSF Approach and Landing Accident Reduction (ALAR) Toolkit, which comprises a detailed study of CFIT together with much valuable advice on accident avoidance. For more information, refer to www.flightsafety.org.

Specific lessons learned from the above accident are listed below:

- Place the aircraft call sign at the beginning of a message. This allows pilots to identify messages intended for them quickly and reduces the chance of a message being acted on by the wrong pilot;
- After satisfactory communication has been established, abbreviated call signs may be used provided that no confusion is likely to arise
- Advise adjacent sectors/airports if it is felt that potential confusion may exist between aircraft likely to enter their airspace
- A transmission could be blocked when two or more aircraft are responding to the same clearance. Typically the controller would hear a partial or garbled read-back. If a blocked transmission is suspected, ensure that both aircraft retransmit their messages and confirm carefully that a clearance has not been taken by an aircraft for which it was not intended.

UNAUTHORISED PENETRATION OF AIRSPACE

Almost invariably, unauthorised penetration of airspace occurs due to pilot error. In many cases, unauthorised penetration involves GA aircraft which accidentally stray into controlled or restricted airspace, often due to inaccurate navigation, lack of awareness of the location of the airspace, lack of knowledge of the procedures for obtaining clearance to enter the airspace, or poor communication technique.



Military aircraft too, are often responsible for airspace infringement. The cause may be sudden deterioration of weather, particularly when low flying is being undertaken, coupled with inability to communicate with civil air traffic authorities due to incompatibility of RTF equipment (many military aircraft are equipped with UHF radios only).

In the cases cited above, the ATCO's best defence is awareness of the problem; when, where and how it is most likely to occur; and constant vigilance, especially when unidentified radar returns are observed approaching controlled airspace from outside. Usually, the only action the ATCO can take is to issue avoiding action to aircraft under control.

The ATCO should always report airspace infringement, even when no danger (e.g. loss of separation) results, and regardless of whether the culprit is identified. Reporting action, the subsequent investigation process and detection of the intruder help raise awareness of the issue.

The nature of commercial airline operation is such that airliners usually conduct the whole of their flight within controlled airspace; therefore, unauthorised penetration seldom occurs. However, there have been examples of penetration of military danger areas due to early turns. An example of this is reproduced below.

Early Turns

Introduction

Occasionally, control staff report aircraft turning (very) early before an en-route point, in some cases flying on the edge or even within military areas. In modern aircraft, this seems to be a "feature" of the state-of-the-art navigation system. According to aircraft manufacturers, it "smoothens" the turn, increases passenger comfort and minimises the mileage flown.

As it introduces some uncertainty to what the aircraft is doing, this aircraft behaviour can be annoying for ATC. The early turn should result in the aircraft exactly over-flying the corner edge of the two crossing airways. In the example from the NICKY sector, it is the crossing of the dotted blue lines in the plotting.

The Problem

However, if you modify the routing of the aircraft, e.g. by clearing the aircraft from NIK direct to DIK in the example, the FMS will aim for the corner edge of the new, non-existing route NIK-DIK, which is almost, but not quite the same as NIK-BUB-DIK. By omitting the 3° left turn in BUB, the corner which the aircraft aims for shifts slightly. As a result in the aircraft briefly enters the restricted airspace, in this case the TRA-North.

Technically, the early turns are within the RNAV specification and there's little to prevent aircraft from "optimizing" the space available in an airway. In this particular case, controllers are advised not to clear aircraft from NIK direct to DIK when the TRA-North is active. If similar situations exist in your area of operation, you might consider recommending similar advice.

Conclusion

These situations are of course not limited to the TRA North corner. Some airways have "do-not-turn-before" points defined in the AIP to avoid coming too close to military areas etc. But keep in mind that even when there is no restricted area, the issue can still affect conflict geometry and how you solve them. If you really need the aircraft to stay on a route to avoid TRA's or other aircraft, the surest way is to lock them on headings.

WAKE VORTEX TURBULENCE

Throughout the world, many thousands of wake vortex incidents occur every year. Thankfully, these incidents are seldom serious, although they are often very frightening to passengers and crew and may result in injuries to persons who are not strapped in, or if loose articles are thrown about the cabin. IFALPA[4] considers Wake Vortex to be a seriously under-reported issue.

A few fatal accidents have been attributed, directly or indirectly, to wake turbulence. The most recent of these involved the loss of American Airlines Flight 587, a summary of which follows.

American Airlines Flight 587

On November 12, 2001, American Airlines flight 587, an Airbus A300, crashed into a residential area of Belle Harbour, New York, shortly after takeoff from John F. Kennedy International Airport New York. Flight 587 was a scheduled passenger flight with 2 flight crew members, 7 flight attendants, and 251 passengers on board. The airplane's vertical stabilizer and rudder separated in flight and were found in Jamaica Bay, about 1 mile north of the main wreckage site. The airplane's engines subsequently separated in flight and were found several blocks north and east of the main wreckage site. All 260 people aboard the airplane and 5 people on the ground were killed.

The accident report[5] finds that the aircraft encountered two wake turbulence events and that the first officer responded to these with excessive rudder pedal inputs which resulted in the fracture of the vertical stabilizer from the fuselage. This accident was not caused by the wake turbulence itself, but by the pilot's reaction to it; however, it demonstrates the potential danger of wake vortices where pilot response is sub-optimal.

The Role Of The Air Traffic Controller

The role of the air traffic controller is crucial in reducing the number and seriousness of wake vortex turbulence. The ATCO has to walk the fine dividing line between optimizing traffic flow at his/her airport and maintaining a high level of safety.

ICAO regulations specify minimum separation standards for aircraft arriving at and departing from airports. In some cases, these standards have been increased by ANSPs in the light of actual experience.

Radar Separation

Leading Aircraft	Following Aircraft	Separation Distance
Heavy	Heavy	4nm
Heavy	Medium	5nm
Heavy	Light	6nm
Medium	Light	5nm

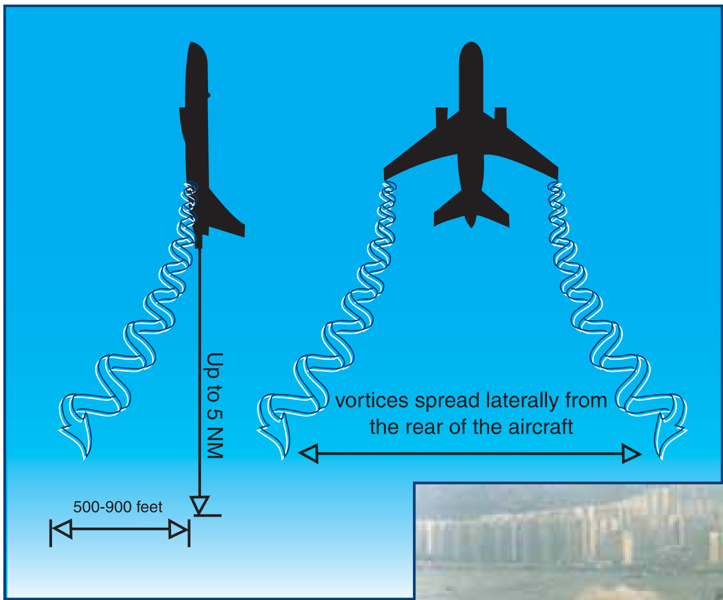
Non-radar Separation

Leading Aircraft	Following Aircraft	Separation Time Arriving	Separation Time Departing
Heavy	Medium	2 minutes	2 minutes*
Heavy	Light	3 minutes	2 minutes*
Medium	Light	3 minutes	2 minutes*

* 3 minutes if taking off from an intermediate position

4 IFALPA - International Federation of Air Line pilots' Associations
5 See http: //www.ntsb.gov/publictn/2004/AAR0404.pdf

In practice, these standards are a crude tool, for the circumstances which may give rise to wake turbulence are extremely complex. The following paragraphs, which explain some of these circumstances, are intended to help the ATCO apply the minimum separation standards intelligently.



All aircraft generate vortices at the wing tips as a consequence of producing lift. The heavier the aircraft and the slower it is flying, the stronger the vortex.

Among other factors, the size of the vortex is proportional to the span of the aircraft which generates it, for instance a Boeing 747, with a span of 65metres trails a vortex from both wingtips each with a diameter of around 65 metres.

Some aircraft, notably the Boeing 757, have particularly strong wake turbulence characteristics which can be experienced at much greater distances than would be expected, given the aircraft's weight.

At low altitudes, vortices generally persist for as long as 80 seconds, but in very light or calm wind conditions, they can last for up to two and a half minutes. Once formed, vortices continue to descend until they decay (or reach the ground). Decay is usually sudden and occurs more quickly in windy conditions. Cross-winds can carry a vortex away from the flight path of the aircraft. For each nautical mile behind an aircraft, the vortex the aircraft generates will typically have descended between 100 and 200 ft. Some pilots have reported encountering wake turbulence as much as 20 miles behind and 1000ft below a preceding aircraft.

Generally, the lighter the aircraft, the greater the degree of upset if a wake vortex is encountered. Thus, a light aircraft will be vulnerable to the vortices of a similar sized aircraft ahead of it, and microlight aircraft will be even more vulnerable.

A light aircraft penetrating a vortex from a larger aircraft on a similar trajectory and axis can experience a severe roll. In the worst cases it may be beyond the power of the ailerons to counteract the roll. Even executive jets have been rolled upside down.

If the vortex is entered at right angles to its axis, rapid vertical and pitch displacements with airspeed changes are likely. An oblique entry, the most likely event, will have symptoms of both.

A significant proportion of the wake vortex incidents occur below 200 feet i.e. just before landing where there may not be room to recover. An accident in the UK badly damaged a light aircraft, which it appears got too close behind a landing turboprop. At 100-150 ft the right wing and nose dropped and the aircraft did not respond to control inputs, descended rapidly and hit a hedge. Estimated separation was about 3 nm. The wind speed was reported as 2kt. Incidents including fatal accidents have also occurred shortly after take-off, which is when the affected aircraft is most likely to be directly behind a larger aircraft.

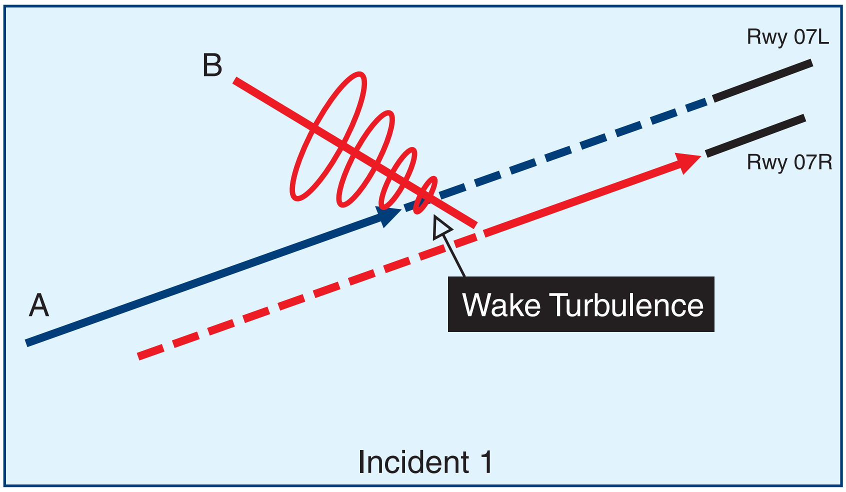
Close to the ground where their effect is most hazardous, vortices generally persist for about 80 seconds. They tend to move apart at about 5 knots in still air, so a crosswind component of 5 knots can keep the upwind vortex stationary on or near the runway while the downwind vortex moves away at about 10 knots. In crosswinds of more than 5 knots, the area of hazard is not necessarily aligned with the flight path of the aircraft ahead. At airfields where intersecting runways are both in use, the location of the vortex may be difficult to predict.

Some Recent Wake Vortex Turbulence Incidents

The following incidents occurred recently at various airports throughout Europe. Some of the reports are very brief, but they serve to indicate the type of problem that may be experienced.

Turbulence may be experienced even when separation from the preceding aircraft is greater than the minimum standards specified.

1. While an A319 (A) was making an ILS approach on Rwy 07L, ATC cleared another aircraft (B) to cross the 07L localiser and join the 07R localiser when less than 2nm ahead of the A319. This caused severe wake turbulence which adversely affected the stability of the A319's approach.



2. An EMB145 on ILS at 3000ft encountered wake turbulence from a B757 3nms ahead. The EMB145 rolled 45 degrees left and the autopilot failed. With the approach stabilised, the autopilot was reconnected. Analysis of the radar recording shows that the EMB145 was vectored onto final approach approximately 4.2nm behind the B757. The required vortex separation is 4nm. As the EMB145 established on the localiser just inside 10nm range, the two aircraft were exactly 4nm apart. Once the B757 reached 4nm from touchdown the crew reduced speed, as is normal, and so there was a normal and acceptable 'catch up'. When the B757 was at a range of 1nm and an altitude of 400 feet, the EMB145 was 3nm behind at an altitude of 1400 feet.

3. A B737 on approach did not comply with speed control. Separation was lost when a following a/c began to catch up the B737. The B737 was repositioned for approach. The operator has stated that approximately 2nms before they were instructed to reduce to 160 kts, the a/c experienced wake turbulence and the autopilot was disengaged. The crew thought they were following a B747 and in order to prevent another vortex encounter, the crew reduced speed to approximately 140 kts without notifying ATC. The crew admitted that their actions caused this incident.

Lessons Learned

The first three items below are specified in ICAO Doc 4444 (PANS ATM).

- Departing aircraft must be separated by at least the minimum spacing specified in ICAO or national regulations
- Arriving aircraft must be separated from preceding aircraft by at least the minimum spacing specified in ICAO or national regulations and must be routed so as to avoid the wake vortex turbulence from departing aircraft
- In light or calm wind conditions, pilots of aircraft following other aircraft at near the minimum specified spacing must be warned that turbulent conditions may persist
- Pilots of aircraft reporting wake vortex turbulence should be encouraged to submit a formal report using the standard Wake Vortex Reporting form
- ATCOs controlling aircraft operating under VFR should remain alert to the danger of wake vortex turbulence and warn pilots if they appear to be approaching too close to the preceding aircraft
- Separation distances should take into account expected manoeuvring, e.g. slowing down or speeding up on approach or departure
- Turbulence may be experienced even when aircraft are separated by the minimum distance; therefore, if traffic circumstances permit, the separation should be increased when wake turbulence is likely.

RUNWAY EXCURSION

Each year we hear of many runway excursion accidents and incidents. Some of these result in tragic loss of life and untold misery for the families and friends of those involved. In other cases, heavy financial losses may result, from the damage to aircraft and the buildings or other items struck by the aircraft, as well as the consequential financial costs, which may be very large. Even when there is no injury and damage is slight, the effect on the airline may be considerable due to loss of passenger confidence etc. The effect of closing a busy airport, even for a short time while the aircraft is cleared from the manoeuvring area, must also be taken into account.

Runway excursions have many causes, including the following:

- Technical malfunction (brakes, landing gear, nose-wheel steering, power units, flaps, speed brakes, etc.)
- Extreme weather (wet or slippery runway, strong or gusting winds, wind shear, turbulence, etc.)
- Pilot error (e.g. unstabilised approach, or decision to land when a go-around or diversion would be more appropriate)
- Controller error (poor positioning for the approach - alignment, height, speed, distance from preceding aircraft, etc.)
- Inadequate weather information (out of date or inaccurate weather reports, meteorological equipment failure).

Ultimately, it is the pilot's decision to land, but he/she has to base that decision on known facts. Of course, he/she may make the wrong decision even when the facts presented to him/her suggest that a go-around would be the right decision - that is beyond our control. But we can try to create an environment which will help the pilot to reach the right decision.

Our training and experience guides us in the right direction by telling us how to line up an aircraft for a successful approach and landing. Our standard operating procedures (SOPs) tell us under what conditions we may refuse permission to land or order a go-around, how often we must pass weather reports, when we must allow the pilot to adjust his/her speed for the landing, and so on.

If we follow our training and the SOPs we will have a clear conscience if the aircraft goes off the runway on landing - or will we? Did the pilot know about unusual conditions at our airport? Did we tell the pilot that the last ten aircraft had diverted due to extreme weather? Did we pass on the landing report made by the previous aircraft? Did we... do everything we could?

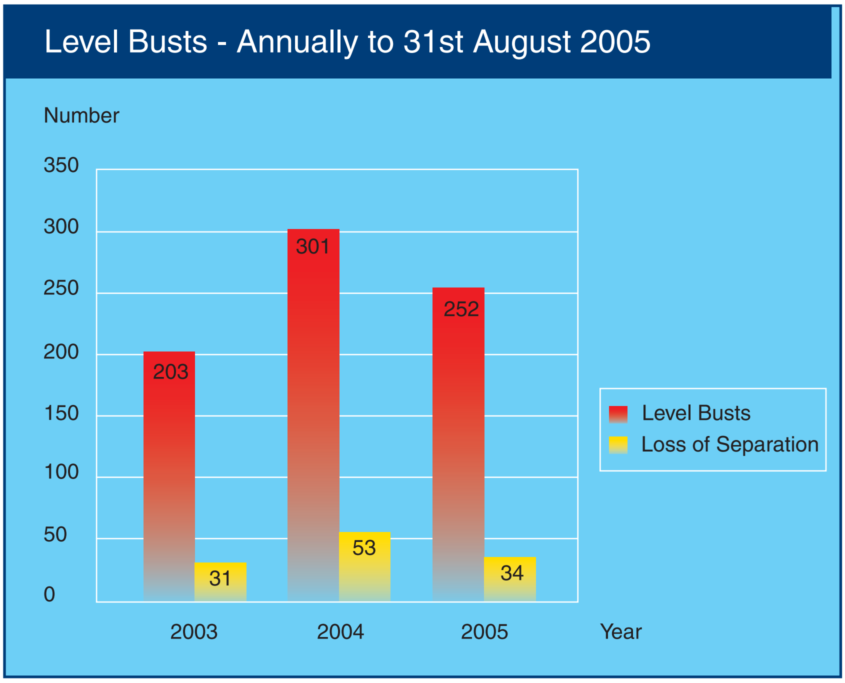
Lessons Learned

From several safety occurrences we recommend:

- Controllers must recognise and understand the pilots' working environments and constraints;
- Controllers have a primary responsibility for safety, therefore the requirement to position aircraft so that a safe approach and landing is possible is overriding;
- Altitude or speed restrictions should be clear and unambiguous and must be removed as soon as they cease to be necessary;
- In bad weather conditions, pass the pilots any additional information that will help them to make the correct landing decision.

LEVEL BUST

The chart below is taken from the UK CAA "Level Best" web-site[6]. It depicts the number of level bust incidents reported annually to UK CAA. At first sight, it seems that the number of level busts is falling, but unfortunately, that is not the case, for the data for 2005 represents only the first 6 months of that year. In fact, there was a 40% increase in the number of incidents reported in 2005 compared with the same period for 2004, and a 100% increase compared with the same period in 2003.



In spite of the first impression given, this chart does not necessarily indicate that the number of level busts is rising. But it does demonstrate the success of efforts made in encouraging pilots and ATCOs to report level busts, even if no loss of separation resulted, even if no one else knew about them.

Japanese Near Miss

The term "near miss" has now been replaced by the more accurately descriptive term "AIRPROX" but the incident described below was indeed a near miss for the 677 passengers and crew of the aircraft involved. The account of the incident is based on article which appeared in the Flight Safety Foundation Digest for March 2004[7]. The incident demonstrates the importance of pilots following TCAS Resolution Advisories (RAs), but it also emphasises the important role of the ATCO in preventing dangerous situations from developing in the first place.

Factual Information

Boeing 747 JA8904, call sign Japan Air 907, was climbing to cruising level en route from Tokyo to Okinawa. McDonnell-Douglas DC-10 JA8546, call sign Japan Air 958 was cruising at FL370 en route to Tokyo from Korea.

There were four pilots on the B747 flight deck: the captain was in the LH seat; the First Officer (FO) was on the jump seat behind the captain; and two trainee pilots receiving training for upgrade to FO occupied the RH seat and the RH jump seat.

The DC-10 had two pilots on the flight deck: the FO, who was receiving training for upgrade to captain, was in the LH seat; the captain was in the RH seat; a flight engineer was also positioned on the flight deck.

The Tokyo Area Control Centre (ACC) was controlled by three ATCOs: the radar controller (the ATCO), who was receiving familiarisation training on the sector; the watch supervisor and an ATC coordinator.

At 1541, the B747 reported that they were passing 11,000 feet for FL390. The ATCO cleared them direct to the YAIZU NDB and to stop their climb at FL350. The altitude restriction was due to another aircraft, American Airlines 157, which was cruising at FL390, and was being controlled by another sector.

The B747 captain told investigators that at this time he could see a contrail at 11 o'clock: "it was at a higher altitude and approximately 40nm from our position," the captain said, "I talked with the trainee pilot about how close the traffic would become before being displayed on the navigational display. The traffic was displayed when it reached 25nm. From the TCAS the altitude was determined FL370. The cockpit crew discussed that we should keep an eye on the traffic."

Between 1543 and 1552 the ATCO handled 14 aircraft and made 37 radio transmissions under the guidance of the watch supervisor. The ATCO told the investigation that, "the traffic volume at the time of the on-the-job training was at about the level I could handle."

At 1546, the B747 was on a westerly track, east of YAIZU climbing through 21,600 feet. The flight was cleared to climb to FL390.

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[6] www.levelbust.com/

[7] Bracing the Last Line of Defense Against Midar Collisions. See www.flightsafety.org/home.html

At 1547, the ATCO instructed Flight 157 to descend to FL350, but as the aircraft was not yet on frequency he received no response.

At 1548, the DC-10 checked in at FL370. At that time it was on an easterly track, west of YAIZU.

Shortly afterwards, Flight 157 checked in at FL390 and was cleared to FL350. This instruction was acknowledged and the aircraft began to descend.

Near YAIZU, the B747 began a climbing left turn from a heading of 270º to 207º. At about the same time the DC-10 was heading 095º and the FO told the captain that he could see traffic at 10 o'clock to 11 o'clock position. At that time the B747 was displayed on the DC-10's TCAS, climbing.

"The traffic was displayed on the TCAS screen beyond the 10-mile arc at between 12 and 13 nm," the DC-10 captain said. "As we saw the other aircraft turning over YAIZU a TCAS 'Traffic, Traffic' Traffic Advisory (TA) sounded while we were about 10nm distant at FL370. From the TCAS the other aircraft's altitude was determined to be also FL370. The Pilot Flying (PF) disengaged the autothrottles in anticipation of an RA.

The ATC watch supervisor was providing comments to the ATCO about the tasks he had to perform and was discussing the traffic situation with the ATCO at 1554:18, when a conflict alert was displayed on the ATCO's radar screen.

The ATCO could not remember at what time he received the hand-off of the DC-10 from the adjacent sector, but he first became aware of its presence when the conflict alert operated and the letters 'CNF' flashed in the data blocks of the DC-10 and the B747.

The ATC watch supervisor said, "I was in a flurry because I had forgotten about the presence of [the DC-10]. At that time I deemed that the best action was to [issue an instruction to the DC-10 crew to] descend."

The ATCO, however, instructed the B747 to descend to FL350. The B747 crew acknowledged the instruction giving also their call sign and told the ATCO, "Traffic in sight." Even so, neither the ATCO nor the watch supervisor noticed that it was the B747, not the DC-10 that acknowledged the descent instruction; indeed, the watch supervisor stated that she was convinced at the time that the ATCO had issued the instruction to the DC-10.

As the B747 crew had been instructed to descend during a climb, the captain disengaged the autopilot and autothrottles and reduced power to idle while commencing the descent. The aircraft climbed to around FL371 due to its inertia before beginning to descend.

At 1554:34, just 16 seconds after the conflict alert was displayed on the ATCO's screen, the DC-10 received an RA calling for descent at 1,500 ft/min. One second later, the B747 received an RA calling for a 1,500 ft/min climb.

On the DC-10, the autopilot was disengaged, idle power was set, and the nose was lowered to increase the rate of descent.

On the B747, the aircraft had begun to descend when the climb RA was received, and the captain decided to continue the descent. "At that time, I observed the other aircraft approaching from the forward right at about the same altitude, but I had already initiated the descent and, judging that the best way to avoid a collision at that altitude would be to continue descending contrary to the TCAS command, I continued descending to FL350, the captain said. "Further, I also considered the risk of stalling if we pitched up, given the insufficient thrust, leading to an even more dangerous sitation."

Investigators calculated that the B747 had a margin of about 65kt over the stall speed, and considered that the aircraft, "would have been able to gain altitude to some extent using this airspeed margin for climb by transforming kinetic energy into potential energy."

Observing that the DC-10 was not descending, during the next few seconds the ATCO twice instructed the crew to turn right for separation; however, the crew did not respond to either instruction, and probably did not hear them due to the cockpit workload at that time. The watch controller then took over radio communications and instructed "JAL957" to begin a descent; at that time, there was no aircraft with that call sign in the sector's airspace.

At 1554:49 as the DC-10 was descending through FL369, the crew received an "increase descent" RA, calling for a descent of 2,500 fpm. To achieve this, the captain extended the speed brakes while the FO lowered the nose further. The FO told the investigators, "I felt as if the other aircraft was rapidly rushing towards us and I wondered why, since our aircraft was following the TCAS descent command."

Between 1554:51 and 1555:11 the B747 descended from 36,900 feet to 35,500 feet and the DC-10 descended from 36,900 feet to 35,700 feet.

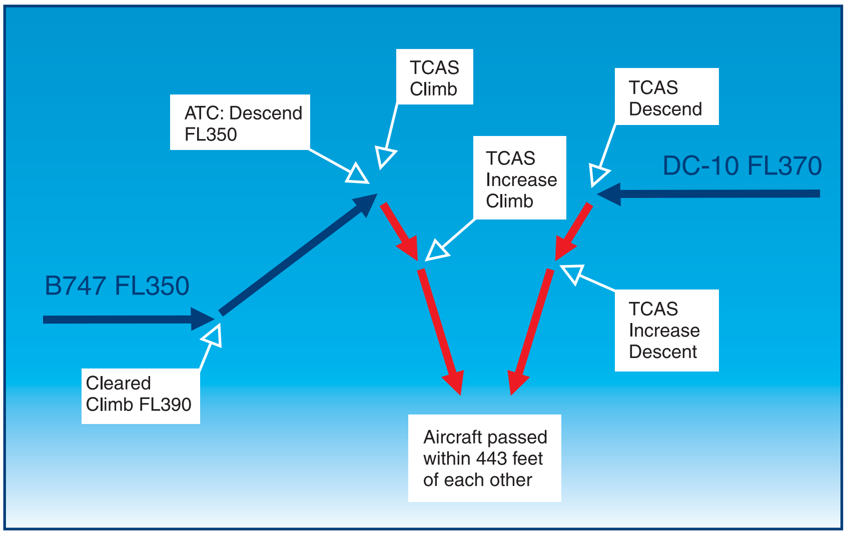
At 1555:06 the B-747 crew received an "increase climb" RA calling for 2,500 fpm climb but the captain continued the descent.

The DC-10 captain could see the top of the B747's fuselage and judged that it was increasing its descent rate. The pilots had no time to communicate and both pulled back on the yokes together. The B-747 passed beneath them.

Analysis of recorded data indicates that the aircraft passed within horizontally 135 metres (443 feet) of each other. If the B747 had climbed in response to the initial RA, and had continued to climb, it is estimated that the aircraft would have been separated by 1,600 feet vertically when they passed each other.

Analysis

The decision of the B747 captain to follow ATC instructions instead of the TCAS RA was a major cause of this incident. ATC were not informed by either crew that they had received an RA, nor did the DC-10 crew inform ATC that they were following their RA. This omission increased the uncertainty on the part of the controllers, and the ATCO continued to issue instructions which contradicted the TCAS (although they could not have known that).



Subsequently, ICAO ruled[8] that pilots must follow TCAS RAs regardless of contrary ATC instructions; if for any reason it is not possible to follow the RA, aircraft must remain level rather than take action in the opposite direction to that indicated by the RA. ICAO also requires pilots to notify ATC as soon as possible.

American Airlines 157 was cleared to descend before the aircraft was on frequency. This error had no direct influence on subsequent events.

Both the ATCO and the watch supervisor 'forgot' the presence of the DC-10, even though it had checked in on frequency only a few minutes before.

These two events may indicate that the ATCO was overloaded at the time. Also, the fact that the ATCO and supervisor were in discussion may have distracted their attention from the approaching confliction, which should have been evident from the indications on the radar screen.

Both the ATCO and the watch supervisor were taken by surprise when the conflict alert was signalled. Having decided to descend the DC-10, the ATCO accidentally issued the descent instruction to the B747. Neither the ATCO nor the supervisor noticed this error, nor did they notice that the B747 accepted the clearance. In spite of subsequent events, neither controller suspected that this error had occurred.

When the watch supervisor took over control, she issued an instruction to JAL957, even though there was no aircraft with that call sign on frequency. This may have been a sub-conscious combination of the call signs "907" and "958" which belonged to the B747 and the DC-10, resulting from the obvious pressure of the situation. This event was probably too late to have any effect on the outcome of the situation; nevertheless, it is worth noting that this was the second occasion when a controller used an unintended call sign.

Lessons Learned

- In high-pressure situations, take time to ensure that instructions issued are appropriate. Three obvious errors of this type occurred:
    - A clearance was passed to an aircraft which was not on frequency
    - A clearance was twice passed to aircraft using the wrong call sign
- Avoid distractions, especially in high-pressure situations. Sound briefing before and de-briefing after a period of duty is usually more effective and less distracting than discussion during the duty period
- Always take time to up-date your situational model when a new aircraft comes under your control. Attempt to visualise any conflict that may arise with other traffic in the future before moving on to other tasks
- See also 121.5 Safety Alerts - Safety Occurrences during On-the-Job Training on Page 10.

The EUROCONTROL Level Bust Toolkit has been developed as a result of the EUROCONTROL Level Bust Initiative. It contains much important information and advice to help combat the level bust threat. The EUROCONTROL Level Bust Toolkit may be obtained on CD ROM by contacting the Coordinator Safety Improvements Initiative, Mr Tzvetomir Blajev, on
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[8] See ICAO Doc 8168 - Procedures for Air Navigation Services - Operations (PANS-OPS)

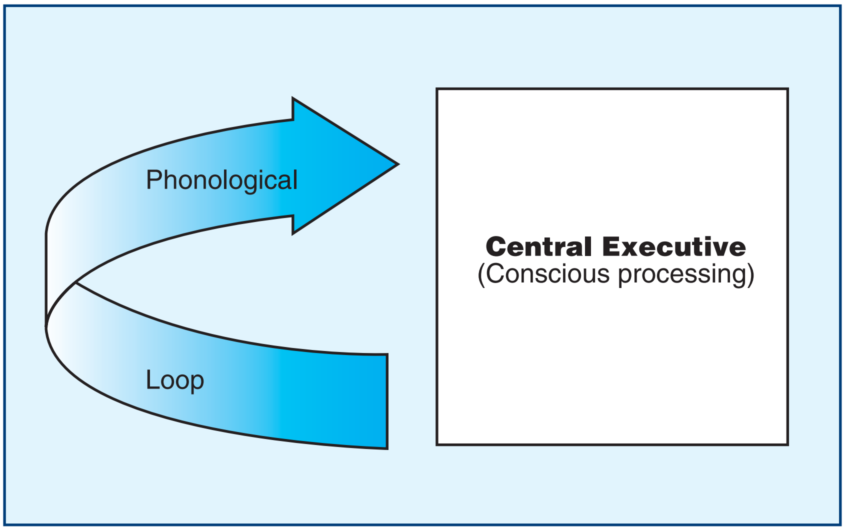
THE PHONOLOGICAL WHAT?

Provided by Airservices Australia

A little known aural memory concept, known as the phonological loop has been identified as contributing to many communication breakdowns, especially information delivery errors. For example:

- Flight data record says aircraft squawk code 1234
- The controller erroneously instructs squawk code 1243
- The pilot correctly reads back code 1243
- The controller compares the pilot's read-back to his incorrect instruction (1243 =1243)
- The controller detects a match and the error goes unnoticed.

The error occurs because the controller can detect the match [instruction code = read-back code] without ever having to process the information. The controller's instruction and the pilot's read-back are both stored in the phonological loop, which is an aural processing area of the brain that does not require conscious effort to store information. Just as you see things and respond without ever consciously processing the information, you can hear things and respond without consciously processing the information also.



It is important that controllers understand the perils associated with anticipating read-backs and accept the logic behind the memory prompts and checks that have been incorporated into the air traffic control system to mitigate these types of risks.

This is just one example of a mix-up that can occur without the controller realising it. We must not rely on those last ditch safety nets, such as STCA and TCAS to save the day - they usually will, but not without leaving a trail of frightened pilots and controllers (and perhaps passengers too). The best defence lies in good team work, encouraging members of the team to look out for errors, especially when the pressure is on. This in turn relies on strong leadership and a sound safety culture, reinforced by regular Team Resource Management training.

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

Win a Free trip for Two to Paris

We wish to encourage controllers to give us proposals for safety improvements based on their experience. All proposals received by the Editor in Chief by the end of April 2006 will be assessed by an independent Jury. The controller which submits the best proposal will receive a free weekend for two in Paris. Proposals should be supported by argument and include the contact details of the person submitting the proposal. The winning entry will be featured in the next edition of HindSight."

DISCLAIMER

This publication has been prepared by the Safety Improvement Sub-Group (SISG) of EUROCONTROL. The authors acknowledge the assistance given by many sources in the preparation of this publication.

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Putting Safety First in
Air Traffic Management

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