Instrument Pilot

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B737 FMS
Ed Follet describes how they operate on page 12

PPL/IR EUROPE

Hypoxia– the killer that hides itself

Compiled by David Bruford

There was talk recently of reducing the height at which unpressurised aircraft could be piloted without supplementary oxygen. Nigel Everett came up with the suggestion that it might be useful for some of us to undergo mild hypoxia in a compression chamber but first carried out some research to avoid, as he put it 'reinventing the wheel' and discovered the holy grail of hypoxia investigations for pilots. *The FAA Office of Aerospace Medicine Civil Aerospace Medical Institute Publications Aviation Medicine Reports No: DOT/FAA/AM-97/9*. Entitled, *Effects of Mild Hypoxia on Pilot Performance at General Aviation Altitudes*, it reports on a moderately recent study carried out in April 1997.

In its abstract the FAA rule that general aviation pilots may fly continuously at altitudes up to 12,500 ft. without the use of supplemental oxygen is stated. It goes on to say: "However, hypoxia is a condition that can develop at altitudes under 12,500 ft. Research has shown highly variable tolerance and performance of individuals during low altitude laboratory exposures with simple and complex tasking. This study evaluated the physiological and subjective responses, as well as the simulated flight performance of general aviation pilots during a cross-country flight scenario. Ten pilots of a mild hypoxia group were compared with ten pilots of a normoxic control group. Measurements of flight performance from the Basic General Aviation Research Simulator (BGARS) and of flight-following procedures were gathered during a 3-day, 2 hour per day, cross-country flight scenario. Determined by group membership and terrain elevation during the cross-country flight, subjects breathed either oxygen mixtures simulating sea level, 8,000 ft, 10,000 ft and 12,500 ft altitudes, or compressed air throughout. The physiological measures of oxygen and carbon dioxide partial pressures ($PtcO_2$ and $PtcCO_2$), heart rate (HR), and blood oxygen saturation (SaO_2), provided significant results differentiating the 2 pilot groups and the 4 altitude conditions of the hypoxia group. No significant deviations from assigned altitude, VOR radials, or heading were found during cruise flight. However, significantly more procedural errors were committed by the hypoxia group during cruise flight at 10,000 ft and during the descent and approach phases of flight from 10,000 ft. on Day 3 and during descent from 12,500 ft. on Day 4. Subjective measures of symptoms, workload, and stress provided limited evidence of hypoxic effects, although the hypoxia group reported significantly greater demands on their time during flight, compared to the control group. Also, significant group differences were found in flight following procedural errors, particularly during the descent and approach phases of flight. Recommendations are made to encourage GA pilots to plan their descents from flights above 10,000 ft to allow sufficient recovery time as a routine precaution to the often undetectable effects of mild hypoxia." The full report runs to 43 pages but I've extracted some information that should be found as particularly relevant.

P 2►

"Significantly more procedural errors were committed by the hypoxia group during cruise flight at 10,000 ft and during the descent and approach"

> “Unsafe and high risk piloting behavior was recorded during the final phases of flight for many subjects of the hypoxia group”

Subjects

Twenty private pilot subjects were recruited as paid volunteers from a local Part 141 flight training school with national and international clientele. The subjects varied in age from 19 to 32 with an average of 186 total fight hours. During the last 90 days they averaged 91 hours. All subjects performed a pulmonary function test (PFT) to determine normal lung functioning. Ten subjects were randomly assigned to either a hypoxia group or a control group. The hypoxia group breathed altitude-equivalent oxygen mixtures to simulate environmental flight conditions in the research simulator.

Simulated Altitudes

Various reduced oxygen-breathing mixtures (primary standard purity, +/-0.5 %) were used to simulate the following altitudes:

- Sea level (SL) = 21% oxygen, balance nitrogen (Grade E Compressed Air)
- 8,000 ft (2438 m) = 15.5% oxygen, balance nitrogen
- 10,000 ft (3048 m) = 14.3% oxygen, balance nitrogen
- 12,500 ft (3810 m) = 13.0% oxygen, balance nitrogen.

Sixteen flight performance variables were collected with an aero-model emulating a Beech Sundowner aircraft and two hours of flight data were recorded each day of a cross-country scenario.

Procedural Error Data

Pilot procedural error and other pilot behaviors were recorded during each session by the experimenters. This data was collected as additional indices of pilot performance. These measures were classified into 12 error categories as shown in the chart below:

1. Misdialed frequency or transponder codes
2. Failed to use reciprocal value when setting OBS for the *inbound* radial
3. Failed to report radial intercept, level at altitude etc, as previously instructed by ATC
4. Deviated from course by inattention or distraction (eg reading chart, dropping chart)
5. Failed to follow ATC instruction
6. Landed downwind
7. Crashed on landing attempt
8. Failed to recognise airport (even after reporting “in sight”)
9. Missed approach (did not land on initial attempt, had to go around)
10. Premature maneuver or radio contact
11. Landed in wrong location
12. Dialed incorrect OBS letting (unrelated to inbound reciprocal)

The procedural error records were revised and categorized by the experimenters. The approach used to evaluate the error data was to parse the data by (1) error category, (2) altitude, (3) cruise-segment and (4) phase of the flight. A visual inspection of all the data suggested general group differences.

Statistically significant group

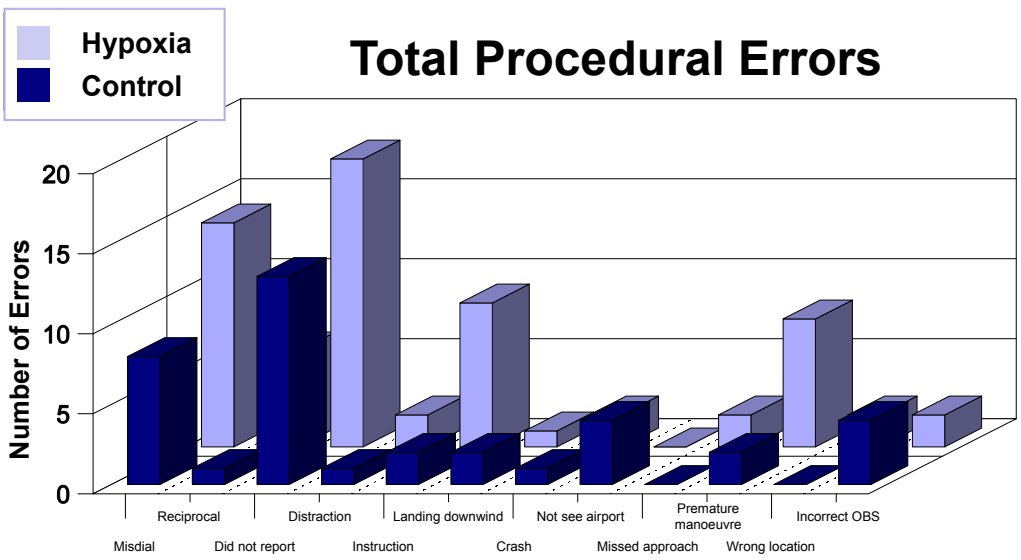
Differences were found in the number of errors committed during flight over the 3-day scenario by nonparametric tests. Reduced by phase of flight, significant group differences were found during the cruise phase at 10,000 ft and during the descent phase from 10,000 ft on Day 3, and during the descent phase from 12,500 ft on Day 4. A non-significant trend of increased errors also occurred on Day 2 during descent from 8,000 ft. The descents and combined approach phases of the study occurred at the end of the daily flights were also at the end of each 2-hour session. Subjects in the hypoxia group had therefore been breathing reduced oxygen for up to 2 hours at the time of descent which is an important point because it is consistent with flights in the real world.

Flights at GA altitudes for any length of time are followed by descent, approach and landing phases of flight. Some aircraft accident data suggests that, compared to the amount of time spent in various phases of flight, a moderate proportion of consequential events occur during the descent and approach. These data highlight the criticality of committing errors during the end of any flight and the need for careful piloting performance.

In a break down of the types of errors that were committed by the hypoxia group during descent, the following were found:

1. Four different pilots on Day 2 initiated premature flight maneuvers (changing heading and/or altitude before instructed).
2. One different pilot on each day misdialed a radio frequency.
3. One different pilot during Days 2 and 4 failed to follow ATC instructions.
4. Two different pilots flew a missed approach on Days 2 and 4.
5. One pilot crashed while descending on Day3 (he failed to check ground elevation on the chart).
6. Four different pilots misreported seeing the airport or field on Days 3 and 4 and required additional instructions.

The last error in the above list was of interest because all subjects were requested to report when the airport was in sight and each of the four hypoxia group pilots making the error reported sighting the airport but continued their flights over the field even with the centerline clearly



visible in the display. Each of these pilots maintained their headings well beyond the field and eventually requested ATC assistance and vectors back towards the field. None of the control group subjects had difficulty identifying the airports. Some aspect of reduced vision may have been a factor for the hypoxic subjects to over fly the field or perhaps a form of behavioral fixedness could have occurred in these subjects to maintain their last given heading.

Regardless, after reviewing the physiological data subjective reports, procedural error data, and laboratory notes for these subjects it was concluded that subtle effects of hypoxia were observed in the experimental group. Unsafe and high-risk piloting behavior was recorded during the final phases of flight for many subjects of the hypoxia group, particularly from the 10,000 ft and 12,500 ft altitudes. Subjects of the control group, though not error-free over the 3 days, exhibited deliberate and cautious behavior during the last critical phases of flight; often asking for additional weather and field-condition information. Some of the control group pilots were also observed to descend slowly outside of the landing pattern and only entered the pattern after their intentions were announced. Few, if any, of the experimental subjects conducted their descents and approaches in this manner. Hurried and precipitous behavior was often seen during descents for many pilots of the hypoxia group.

Recommendations

In summary, this study did not provide unequivocal evidence of detrimental flight performance due to the mild hypoxia found during the cruise segments at 8,000, 10,000 and 12,500 ft simulated altitudes. However observed performance during the descent and approach phases of flight was considered to be generally unsafe with potentially deleterious outcomes. Because of the known individual variability in tolerance to hypoxia, erring on the side of caution is recommended from the results of this study. Descents from GA flights of greater than 2 hours at these commonly flown altitudes should proceed slowly and cautiously. Heightened awareness of the potential risks of making critical error following flights at these altitudes should foster the routine practice of planning a slow descent with enough time at a nominally lower altitude (eg 7,000 ft or 6,000 ft when possible) for physiological recovery before the approach and landing phases of flight are continued. Pilots may not perceive symptoms of mild hypoxia at the time of their descent procedures, but this should not suggest to the individual that hypoxia is not present. Even subtle effects can have unanticipated influence on the pilot preparing for approach and landing at uncontrolled fields.

The full report can be sent to members on request. It is possible check for in-flight hypoxia by monitoring your blood oxygen saturation and pulse rate with an electronic gizmo such as the FlightStat Pulse Oximeter. This is a very compact, self-contained unit that slips onto your finger and displays reliable (according to the manufacturer) data. It provides 18 hours of measurement time (1600 - 40 sec. checks) and is powered by two AAA batteries. The web site is http://www.flightstat.nonin.com/product_info.htm and in the UK http://www.afeonline.com (Airplan Flight Equipment / RD Aviation - Oxford Airport - Kidlington) sells them at £245.95 plus postage and VAT. Contact tech@afeonline.com or telephone 01865 841441.

*The **FlightStat Pulse Oximeter** emits red and infrared light through your finger and detects the fluctuating signals caused by the pulsating blood flow. Your pulse rate is determined from the signals received by a light detector. The ratio of the fluctuation of the red and infrared light signals is used to calculate your blood oxygen saturation (%SpO2) of hemoglobin*

The problem with hypoxia is that as it takes effect, the pilot does not get any warning. With carbon monoxide poisoning there is at least a feeling of illness. With hypoxia quite the opposite can occur where the pilot feels *more* confident and relaxed than at normal oxygen levels. The effect of hypoxia masks itself and for that reason should be feared, planned-for and anticipated.

Hypobaric Hypoxia - A probable factor

On 4 September 2000, a Beech Super King Air 200 aircraft, VH-SKC, departed Perth, Western Australia at 1009 UTC on a charter flight to Leonora with one pilot and seven passengers on board.

For the first 12 minutes of the flight, the operation of the aircraft and the communications with the pilot appeared normal. However, shortly after the aircraft had climbed through its assigned altitude, the pilot's speech became significantly impaired and he appeared unable to respond to ATS instructions. Several open microphone transmissions over the next 10-minute period revealed the progressive deterioration of the pilot towards unconsciousness and the absence of any sounds of passenger activity in the aircraft. Five hours after taking off from Perth, the aircraft collided with the ground near Burketown, Queensland, and was destroyed. There were no survivors.

The investigation concluded that the incapacitation of the pilot and passengers was probably a result of hypobaric hypoxia due to the aircraft being fully or partially unpressurised and their not receiving supplemental oxygen. Due to the extensive damage to the aircraft the investigation could not determine the reason for the aircraft being unpressurised, or why the pilot and passengers did not receive supplemental oxygen.

INTELLIGENCE REPORTS

Compiled by Nich Overend,
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A Happy 2004 to all Intelrep readers… I hope you all got everything that your hearts desired for Christmas, and that you will all have no trouble keeping all your New Year resolutions!

Aussie rules, no football…

Australian pilots of all aircraft except those in the Australian sports category are now required to submit to background checking prior to the issue of a new photographic licence. To add insult to injury the pilots themselves must pay the AUS$200 (about £85) to cover the checks, and their new license will only be valid for two years!

This is part of the Australian Department of Transport's new security push which includes compulsory anti-theft measures for general aviation aircraft such as auxiliary locks for propellers or prop controls, with random compliance checks from Security Investigators!

This also means that the straightforward conversion of your ICAO license to a CASA Australian license on production of a valid medical has now ceased! According to the CAA you must fill out a CAA Authorisation form SRG\1160 and send it back to the CAA (with a £15 payment). Then a CASA application form and send it to a CASA office. CASA then talk to the CAA and (hopefully) everything gets sorted out. Obviously this is likely to take a little while, so start well in advance for your trip!!!

Further information on Australian security can be found here:
http://www.dotars.gov.au/transsec/fact_sheet6.aspx.

Further information on getting an Australian special license:
http://www.caa.co.uk/srg/licensing/fcl/whatsnew.asp?groupid=626
http://www.casa.gov.au/avreg/fcl_lic/overbr.htm

GA Cross-Heathrow mini-route now open 24/7…

Ha! You wish! Now that really would be a news story! Actually it's LAX who according to AOPA US have solved their internal logistical problems and can now allow GA to transition straight over both LAX runways 24 hours a day!

AOPA said, "It is imperative that general aviation VFR traffic has adequate access through L.A.'s Class B airspace." The original Shoreline Transition Route was suspended after several instances of airliners getting too close to VFR traffic. OK, well, nothing strange about that… Those VFR pilots, always getting in everyone's way… Oh hang on – according to AOPA, it appears that the VFR pilots were never at fault! But wait, that must mean…

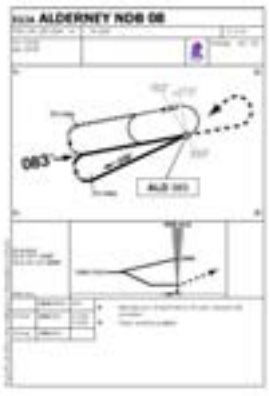
More info from AOPA:
http://www.aopa.org/whatsnew/newsitems/2003/03-4-120x.html

Garmin upgrade for Mode S transponders

Garmin released software version 3.03 for their model GTX330 and GTX330D Mode S transponders. This software fixes a problem whereby the transponders may not reply to TCAS (Traffic Collision Avoidance System) interrogations under some circumstances. Anyone who has not already upgraded their transponders should contact Garmin International for upgrade details, as the upgrade is apparently completely free of charge!

Further information from http://www.garmin.com/aviation/

IFR procedure Pay-Per-Charting



A new company gCAP Ltd has produced the first set of IFR plates specifically designed for helicopters and Category A aircraft. In addition they have priced the plates at a level that practically all GA users can afford. Either £49 for a year's complete access with update notification, or 50p per plate downloaded but with no notifications, so I suppose they want you to download the plate each time…

The charts have been substantially simplified, but there are several comments both on the site's guestbook and in reviews to the effect that maybe they have been slightly over-simplified.

Nigel Webb in Flyer Magazine notes a lack of ILS check-altitude at outer marker and the absence of timings and minima making a localiser-only approach impossible.

In their favour, the editor at GCap does respond to all questions/comments posed in the guestbook, and states that the plates are licensed by the CAA. But with the standard plates freely available on the AIS website, until they move out of the UK into Europe (which is slated to happen this year), their usefulness may be limited. Well worth a look though…

More Information: http://www.gcap.co.uk
CAA AIS Plates: http://www.ais.org.uk (free registration required)

Symphony silent for 6 months

The German company behind OMF Aircraft which manufactures the Symphony 160 has gone bust. However OMF Aircraft, which are based in Quebec, say that they will be back in production around May 2004.

This will be achieved by a combination of financial restructuring (the Quebec government has already pledged a bunch of money and will end up with 49% of the restructured company), new North American suppliers for parts to build the 'planes and Canadian certification.

There are only 42 Symphonys flying at present, but OMF is placing a high priority on continued support for those planes, and their distributors will continue to reserve delivery positions on the 160 and not yet released diesel-powered 135D which will be be powered by the Thielert Centurion 1.7.

Airfield Updates

Airfield Review

At **Leeds/Bradford International Airport,** the south side of the airport has been designated for a business aviation terminal. Over £8m is being invested in the construction of two new hangars with a corporate aviation lounge, a new ramp and dedicated taxiway. The new hangars will cover 6,300 square metres and be able to house four aircraft.

London City Airport has seen the completion of the new Runway Hold Point. The construction, consisting of a concrete platform covering an area of 4,500 square metres, was built over the King George V Dock. The platform stands on one hundred and twenty 25 tonne support beams across fifty-three 30 tonne concrete piles driven 6 metres into the dock bed.

Luton Airport opened its multi-million-pound Echo taxiway on 6th November. Luton may well be London's longest continuously operating commercial airport, but this is the first time in its 65-year history that it has had a one-way aircraft handling and apron system encompassing the whole terminal complex. The taxiway is the first part of the latest multi-million pound investment by airport owner TBI to increase passenger traffic within existing planning consents to help meet capacity requirements for London and South-East England.

The construction of the Defence Aviation Repair Agency's new super hangar at **St. Athan**, South Wales, took another step forward with the arrival of structural steelwork. The structure now being erected at the heart of the station is currently the largest single construction in Wales.

Weston-Super-Mare, Somerset's Helicopter Museum has received planning permission for a new Learning and Discovery Centre. An application has been made for Heritage Lottery Fund support. It will contain a library and archive partially funded by Rolls Royce. The design and layout is being sponsored by Agusta-Westland.

At **Winthorpe, Nottinghamshire** a contractor (Turnstyle Ltd) has now been appointed for the museum project to construct the new south field Site Aircraft Display Hall. The project is being funded by a £453,000 grant from the Heritage Lottery Fund. Construction work on the 2,400 m² Aircraft Display Hall was scheduled to start in early November 2003 and is anticipated to take six months to complete. The new clear-span portal frame building will accommodate the Varsity training aircraft and ten other aircraft currently displayed outside. *(Airfield Review Extra - www.airfield-research-group.co.uk)*

New £8 million Maintenance and Business Executive Aviation Centre at Leeds/ Bradford International Airport

…and in conclusion – a spikey thought…

The following was extracted from the WW1 Royal Flying Corps Monthly Safety Report for December: No. 2 Brief: No. 847 Squadron, 19 December, Aircraft type Spotter Balloon J17983, Total solo 107.00. Pilot Capt. D. Lavendar, Solo in type 32.10.

Captain Lavendar of the Hussars, a balloon observer, unfortunately allowed the spike of his full-dress helmet to impinge against the envelope of his balloon. There was a violent explosion and the balloon carried out a series of fantastic and uncontrollable manoeuvres, whilst rapidly emptying itself of gas. The pilot was thrown clear and escaped injury, as he was lucky enough to land on his helmet. Remarks: This pilot was flying in full-dress uniform because he was the Officer of the Day. In consequence it has been recommended that pilots will not fly during periods of duty as Officer of the Day. Captain Lavendar has subsequently requested an exchange posting to the Patroville Alps, a well-known mule unit of the Basques.

OK… OK! I didn't point out that it was December 1917, but really isn't it just the sort of thing that could still happen??? Read the rest of them on the AOPA UK news page, they're very funny! http://www.aopa.co.uk/newsfromaopa/aopanews.asp

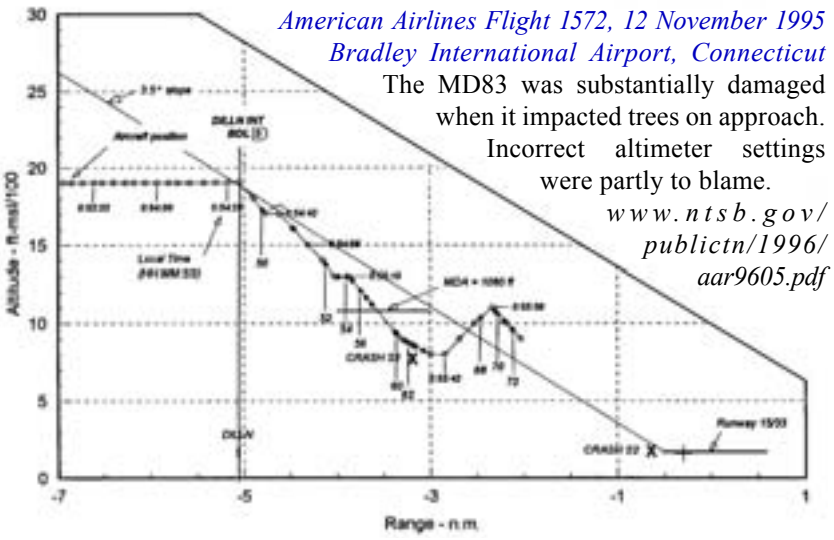
That's all folks – don't forget to send us your snippets of interest, gossip or even some news!

Towards a Common Transition Altitude

A Flight Deck perspective

Part four of a five part series from Eurocontrol covering every aspect of transition altitudes and altimeter setting procedures

Compiled by
David Bruford



American Airlines Flight 1572, 12 November 1995
Bradley International Airport, Connecticut
The MD83 was substantially damaged when it impacted trees on approach. Incorrect altimeter settings were partly to blame.
www.ntsb.gov/publictn/1996/aar9605.pdf

Profile view of the American Airlines Flight 1572 approach

> Very few airlines still use the QFE procedure. American Airlines abandoned its use in 1999

Altimeter crosschecks and associated safety nets

Altimeter crosschecks are performed during climb out and descent. They are intended to compare the different altimeter systems and to detect possible altimeter system errors and mis-settings. These altimeter crosschecks also have a safety net included. Not only are the values of the altimeter systems compared but they are also checked for their correct reference value setting. During climb-out both altimeters need to be reset to the QNE setting when passing through the transition altitude. The altimeters are crosschecked for their QNE setting and a comparison is made in order to detect possible error or mis-settings. During descent the same actions are performed. An additional check is performed during the approach phase to determine which altimeter should be used for the minima call-out.

With a high transition altitude, the flight crew could be given more than one altimeter setting during descent. Different ATC units will issue the altimeter setting when the aircraft descends and executes the approach and landing. An advantage is that a gross altimeter mis-setting could be avoided due to the frequently passed information on the altimeter setting during the descent. The flight crew would detect a previously mis-set altimeter and so the error would be corrected. A drawback, however, would be that the altimeter setting value issued at an early stage of the descent might differ from the final QNH setting to be used during the approach stage of the flight. This could happen with rapidly falling pressure associated with the passage of a frontal system. If the QNH setting is not updated during descent, the resulting QNH setting might be outdated when the approach phase is commenced, leading to a potentially dangerous situation.

During climb out the situation is different. With a high transition altitude the altimeter setting could be forgotten because the attention of the flight crew has shifted to the tasks that need to be performed during the cruise. Changing the altimeter setting could easily be forgotten. This again highlights the fact that the resetting of the altimeter systems needs to be incorporated into an associated action that accompanies a Standard Operating Procedure.

Used in conjunction with an SOP the safety net function is greatly improved. However, to incorporate the altimeter reset into a SOP or an associated action implies that the transition altitude needs to be common. A common transition altitude is therefore essential from a safety viewpoint. A high value for the common transition altitude has, as previously explained, certain drawbacks. A medium altitude (around 10,000 ft) is, for this reason, the most preferred. It coincides with an altitude above which, during climb out, the workload of the flight crew is lowered and the attention is shifted towards other aspects of the flight, e.g. cruise flight management, checking of the elementary aircraft systems, fuel management and initial contact with the cabin crew after take off.

During descent, the workload of the crew increases greatly and the altimeter crosschecks could be done in a hasty manner, thus bypassing the safety net function.

This aspect should not be underestimated as it consists of a mental process that needs a certain amount of time. Distraction or interference with other tasks is detrimental to safety.

As a conclusion it can be stated that by introducing a common transition altitude and incorporating the altimeter setting into a standard procedure, safety is improved.

Special QFE procedure

QFE values are available to flight crew in approach when requested. Altimeters set to QFE indicate the height above threshold and consequently read zero upon landing. If using QFE procedures, during descent and prior to arrival at the Final Approach Fix (FAF), the flight crew uses the QNH setting for intermediate

level off. This setting is set on the standby altimeter.

Upon arrival at the FAF, the flight crew starts using the QFE setting, which is already set on their primary altimeters. If a missed approach is commenced, the flight crew should revert to QNH (on the standby altimeter) for level off.

It was believed that the advantage of the QFE system is the standardization of approaches with regard to altitudes seen by flight crews from the FAF until landing. Especially for Category I precision approaches, which have minimums of 200 ft above ground, each approach no matter what the airport elevation is, will appear the same to flight crews, concerning minimum altitude.

Very few airlines still use the QFE procedure. The last US carrier (American Airlines) using this procedure abandoned its use in 1999. Although the use of QFE does not depend on the transition altitude, it adds to the possible confusion between the different altimeter settings. The workload is extremely high, especially in combination with a low transition altitude.

Abnormal and emergency procedures

Abnormal procedures (e.g. flap problem) and emergency procedures (e.g. engine fire) result in a condition of high workload on the flight deck. First the aircraft needs to be flown and the abnormality or emergency needs to be identified and the necessary actions/checklists need to be performed. An evaluation of the problem and the further course of action will be determined. The normal checklists will be performed when the abnormal/emergency situation is stabilised. If the aircraft climbs through the transition altitude, a reset of the altimeters might easily be overlooked due to the increased level of workload of dealing with the primary tasks. A task prioritisation has to be done and the crew will focus on the abnormal/emergency situation. The normal actions/checklists will be secondary.

If the crew decides to turn back and land at the departure airport, maintaining the same altimeter setting would be advantageous. This means that a reasonably high transition altitude would lower the workload and reduce the possible errors that could be introduced with an altimeter setting change. When a low transition altitude is applicable and an abnormal/emergency situation arises, the crew will need to perform two altimeter setting changes when passing through the transition altitude during climb out and again when returning to the departure airport. This again doubles the potential for error.

An important emergency procedure is the emergency descent procedure. This procedure is applied when a loss of pressurisation (sudden decompression due to structural damage) necessitates a rapid descent to a lower altitude. The altitude that the pilot has to descend to varies according to company policy. A 14,000 ft minimum is a regulatory requirement regarding oxygen for passengers. Various companies use 10,000 ft. In either case the pilot executing the emergency descent has to take into account the safety altitudes. The most important point is that the terrain clearance has to be taken into account. So a reset to a QNH value applicable for the routing should be used when determining a safe level-off altitude. A low transition altitude would therefore be unfavourable. A higher transition altitude would favour incorporation of the altimeter resetting in the flight crew actions when performing the emergency descent manoeuvre, thus leading to fewer errors regarding altimeter settings. It should also be noted that this procedure is one of extremely high workload and the actions that need to be performed are executed in a drill-wise manner.

Training issues

Introducing a common transition altitude will have an effect on the way procedures are trained, especially the altimeter setting actions. Currently setting the altimeters is not incorporated in a procedure or an associated action because of the numerous different transition altitudes. So it is also impossible to train the crew in order to obtain a uniformly applied procedure. With the introduction of a common transition altitude, the altimeter resetting could be integrated in a standard operating procedure or an associated action. Therefore, more emphasis could be put on the exact execution of this procedure and the net result might be a reduction in altimeter resetting errors or mis-settings. Also the training of abnormal/emergency procedures could be improved, as the setting of the altimeters would occur at a defined standard altitude.

For airports requiring a high transition altitude, an exception could be envisaged. As operating into these airports requires special training or briefing, a different transition altitude than the common transition altitude for these special cases does not pose a great problem. The differences can be emphasised during these briefings or simulator training prior to operating into these airports.

Altimeter setting errors - Comparison between US and Europe

Because the US has a common transition altitude, it might be interesting to have a look into some altimeter setting related accidents. However comparison with Europe is very difficult because of the difference in accident databases and available statistical data. It can however be concluded that altimeter setting remains a contributing factor in some accidents. Most of the accidents involve non-precision approaches or loss of situational awareness. Communication problems are at the base of most altimeter setting errors (eg American Airlines MD83, Bradley International, 1995).

European flight crews might be used to the complexity of the European mixed transition altitudes. For flight crew used to a common transition altitude (eg Japan, US, Canada and others) special altitude awareness is needed in the European environment (ION 1851, B707, Azores CFIT, 1989). Attention is given to this (during the training of long haul pilots in the US. Non-European flight crews will benefit the most from the introduction of a common transition altitude.

P 9 ▶

> “Communication problems are at the base of most altimeter setting errors”

Grumpy Old Pilots

(With good reason)

By Jim Thorpe

Slartibartfast, he of the unnecessarily complex Norwegian coastlines, from Douglas Adams' Hitchhikers Guide to the Galaxy

> "We have merged the southern European approach to legislation with the northern European approach to enforcement"

There has been a recent TV series in the UK called grumpy old men. I identified very closely with it and here is a grumpy old pilot's current perspective. By way of background I should explain that for much of my working life I have owned and managed similar businesses in France and the UK. I am a typical product of a middle class upbringing and by and large my starting position as a young adult was the assumption that I would comply with the law. In France I discovered this was not possible. The law was too complex and often quite impossible to implement. Life was made liveable because everybody, including those who made the laws and those whose task was to administer the law knew it was virtually impossible. In reality almost everything was negotiable. In the end the system worked, albeit in a fashion strange to English eyes. In England things were done differently. By and large the laws were easy to understand, had fairly general acceptance and were enforced by people who were firm in their understanding of their role and position in the structure of things. There was little room for negotiation and those who did not comply understood that they were transgressing rules, which were, in the main acceptable to the majority. I do not imply by this that everything in England was wonderful. In the final analysis the French and UK systems were just different. A good standard of life was possible in France or the UK while achieving some sort of rapprochement with the demands of the state.

Gradually in the UK, hugely accelerated by membership of the EC, the law is becoming complex and unworkable. I find now that the attitude that I once reserved for my life in France applies here. My starting position is now not 'this is the law I should obey it' but this is 'some new nonsense which should be avoided if possible'. The added twist is that we have merged the southern European approach to legislation with the northern European approach to enforcement.

Aviation Rules

What has all this to do with aviation? We have some pretty unsatisfactory rules of our own and now we are being positively bombarded by new rules that seem ill thought out and bring minimal benefit. Unsurprisingly people ignore them. The particular difficulty with aviation is that it can be terribly unforgiving to those who violate certain rules. Recently I held over Gloucester where the ATIS was giving 200 meters RVR in shallow freezing fog. This was early morning and I expected this to clear. In fact from overhead I could from time to time see the airfield as the banks of fog shifted. I then heard two Senecas on instrument training taxi out. One took off VFR and the second IFR. Next, VFR inbound traffic that had obviously not heard the weather turned up. On being given the (now) 400 meters visibility by air traffic they said they would approach and land VFR. I continued to hold while wondering if the effort of getting an instrument rating had been worthwhile. Eventually the instrument training traffic cleared the area to do approaches elsewhere and the VFR inbound had a stroke of luck and landed when a patch of fog cleared the upwind end. I continued to hold and some little time later with RVR better but still below minima, I left the area to return low level and land VFR, naturally with appropriate VFR minima.

Slartibartfast

If we are to have rules about VMC and IMC why are they so complex? Why are they different for commercial and private traffic? Why cannot ATC just declare what if any sort of flight is legal? Why do we have an IMC which sometimes makes it legal to fly IFR while most official advice describes it as a get out of trouble rating? The whole area of VMC and approach minima is a mess. Approach designs are little better. Those who were fans of the Hitchhiker's Guide to the Galaxy may remember one particular alien character, Slartibartfast, whose job was to design continents. He was particularly proud of Norway since its coastline was so wonderfully crinkly and unnecessarily complex. All is now clear. The man who was designing the nice simple GPS approaches has been abducted and replaced by an alien who, flushed with his success in Norway, has given us the DME arc.

Shortly after the flight described above we received an aircraft at Gloucester for a pre-purchase survey. It had been operated by a distant instrument training school. The whole of its ancient avionics were placarded as not FM immune. Obviously it had been flying regular illegal IFR for ages. Now I happen to agree that the FM immunity requirement was a complete nonsense and compliance by the vast majority of aircraft was without

benefit. Nevertheless is it not desirable that schools training pilots for their instrument rating should so blatantly ignore the law. In one case they are ignoring a rule with little practical implication but as regards minima they are ignoring a rule, which could kill easily kill you.

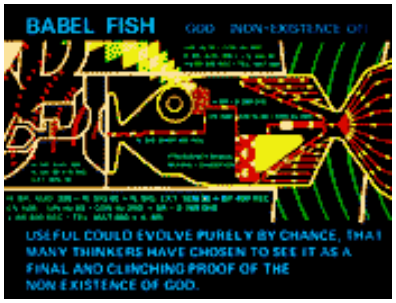
Enforcement Branch?

I never cease to be amazed at the regular admissions in print of law breaking. If one is to believe the press reports the CAA enforcement branch (now that they are part of EASA and further from the centre of things I wonder if they will become the enforcement twig) seems to delight in bringing (and often losing) marginal cases in court. Why not just prosecute the people who have confessed in writing before several thousand witnesses. I am talking about illegal IFR. Every few months some account of a tour includes the heroic description of planned flight in IMC for which the pilots are clearly not qualified. You don't have to monitor an airfield frequency for long on a poor weather day before you will hear a VFR departure into obvious IMC conditions. You don't need to fly that long in French airways without encountering VFR traffic that to say the least has stretched the definitions of VMC.

Surely the starting point of good regulation is to have the widest possible acceptance that it is something which needs regulating because there is evidence that a problem exists. Then we need a regulation, which is properly drafted and can be understood. Thirdly we need fair and visible enforcement lightly applied by which I mean in most first aviation offences compulsory further training not expensive and punitive court appearances.

On the broad front I don't have a problem with the concept of the gradual coming together of Europe. In the aviation world I don't have a problem with the gradual and largely consensual unification of systems of rules that after all are designed to enable us all to fly safely in any country. I do have a problem with a pseudo state, which appears to be both corrupt and inefficient. I do have a problem with a bureaucracy, which is saddling us with a raft of legislation some of which is of doubtful utility and much of which does not have widespread acceptance. This is leading to a diminution of respect for the law, which I suggest we will come to regret. On the broad political front I suggest individuals should support efforts to get the UK out of the EU or at least set firm boundaries on our involvement. As regards aviation I suggest unfortunately we must accept the current reality. Pilots must fund and support PPL/IR Europe and other appropriate aviation groups so that we are informed and can fight hard but constructively for our needs to be accommodated at the earliest stages in the legislative process. Without this private IFR and some forms of VFR flight will cease to exist.

The comments are Jim's personal view and not ***necessarily*** *that of PPL/IR Europe – Ed.*



The babel fish, used as an international translator in Douglas Adams' Hitchhikers Guide to the Galaxy and if it were not fiction, would be very useful to translate current legislation into something meaningful

Towards a Common Transition Altitude
Continued from **Page 7**

Altimeter mis-setting or omission

Primary errors in modern cockpits can be categorised into four types: information errors (slips), decision-making errors (mistakes), task prioritisation allocation errors (CRM-type errors) and equipment malfunctions. The first three types are considered as human errors while the last is equipment related. "Contributory factors" are another element of the error classification scheme. Depending on the amount of information, available for each incident, contributory factors such as fatigue, workload, and wealth are identified.

The lack or loss of situational awareness, particularly the loss of vertical situational awareness, is a causal factor in 50 % of approach-and-landing accidents (ALAR study FSF). Operators on international routes are exposed to different measurement standards in terms of:

- Altitude measurement (feet and metres)
- Altitude reference setting units (hPa or In.Hg)
- Barometric reference (QNH, QNE or QFE)
- Environmental conditions (low OAT operation, rapid pressure changes)
- Radio altimeter setting and callouts (DH)
- GPS altitude

The incorrect setting of the altimeter reference often is the result of one or more of the following factors:

- High workload
- Deviation of normal tasking
- Interruptions and distractions
- Absence of effective cross-check and back-up between crew members
- Communication (read-back/hear-back)

Standardisation is the key to preventing these system-induced errors.

Altitude Deviations by Altitude Pairing

Air safety reports (ASRs) are an important source of information to discover trends in safety related occurrences. ASRs are voluntarily submitted, and thus cannot be considered a measured random sample of the full population of events. The number of ASRs may comprise over half of all the altitude deviations which occur, or it may be just a small fraction of total occurrences. It is clear from ASR statistics that they represent a lower measure of the true number of events which are occurring (J. Reason).

In 1992, the FAA started a human factors study of altitude deviations. The reports indicated that certain altitude clearances are more likely to be misinterpreted than others. This finding emerged after analyses of 191 ASRs reports between 1987 and 1990. The reported altitude misinterpretations were grouped by altitude pairings. It was found that 38 percent of all the reports involved misinterpretations of the 10,000 ft / 11,000 ft altitude pair. The next largest category accounted for less than five percent of the total deviations in the data set. The conclusion here is that it is very easy to confuse one-one thousand with one-zero thousand.

The cause of this specific problem is not clear. Nevertheless, it could be solved partially by setting the transition altitude at exactly 10,000 ft. This would cause a bigger difference in the pronunciation of "ten thousand feet" against "flight level one-one-zero". The change from levels to altitudes (or vice versa) would create a clear distinction between the two numbers. Eleven thousand feet would simply not exist.

Final instalment in the next issue of Instrument Pilot.

Don't take others' competence for granted

by Len Jones

For any of you with the time to read this, I need to get this off my chest and, hopefully, put it all behind me. I confess; I have been prosecuted by the CAA for flying an aircraft without a Certificate of Airworthiness. My flying misdemeanour came to the notice of the Civil Aviation Authority when I decided to change the registration of my Slingsby aircraft from the Swedish to the UK register. I had owned and flown it from March 1999 until September 2001, when I took it to Oaksey Park where a suitable maintenance organisation could do the work required for the relevant paperwork to be issued. It took them until March 2002 (and about £6,000) to get it ready for the CAA to inspect it to give it a Certificate of Airworthiness (C of A). Not that there was anything wrong with the plane, the 'system' requires these inspections to be done even when transferring from one EC country to another.

> "The CAA's bible, the Air Navigation Order says that if a person flies an aircraft without a C of A then they are guilty of an offence"

New Engine

Grant Watson, the CAA airworthiness inspector, duly turned up to inspect the plane and decided two things: The engine was a few months out of date, so to put the plane on the UK register I would have to have a new engine (£16,000-ish). This I did but am looking into the possibility that the CAA were wrong to force me to do this. An aircraft run on 'private' category can normally get extensions if an engineer gives it the OK. Anyway I'm checking on this.

At the time of his inspection, Mr Watson could not find the old Swedish C of As that I should have had to fly the plane legally during the last 2 years. Then, without even contacting me to ask if I had these certificates filed elsewhere, he reported me directly to the CAA's legal department for prosecution.

It is the lack of common decency in not contacting me that annoyed me about this, along with the CAA's attitude of wanting to rush off and prosecute people through the courts rather than even considering trying to educate first-time offenders, such as myself, as to the error of their ways. The really annoying thing is that all the work required for the C of As had been done each year as required. The plane was fully airworthy and the bills from the maintenance organisation (Airtime Aviation in Bournemouth) had been paid. I had even paid the Swedish CAA for the certificate although I have since discovered that the payment went into another aircraft's records. I am not interested in flying a plane that could possibly be less than airworthy. The very thought scares me. My crime was that I did not get the actual piece of paper.

Reasonable Care

The CAA's bible, the Air Navigation Order, says that if a person flies an aircraft without a C of A then they are guilty of an offence – "…unless he can prove that the contravention occurred without his consent or connivance and that he exercised all due diligence to prevent the contravention" and goes on to say "...[or] was due to any cause not avoidable by the exercise of reasonable care". That's it I thought. No problem. So in December 2002 I pleaded Not Guilty at Bournemouth magistrates' court and a trial was set for March 2003. That was an unusually long wait, I thought, but the wait dragged out even longer when, two weeks before that date, the court had to put it off further until 8th May and also transfer it to Wareham. The reason I had to be dragged off to another county to attend court is that I am a magistrate in Somerset and it is not considered good form to be tried by people you know or may know or have heard about or could be a distant cousin to or have seen you in McDonalds in the last two years or…

I telephoned the CAA's head man (Rupert someone?) regarding legal matters and asked him to read the papers and decide was this case really 'in the public interest', as it seemed to me they were using a sledge hammer to crack a nut. He said he would do that and get back to me. About three days later I received a communication from one of his assistants telling me it was to go ahead.

I arrived at Wareham magistrates' court, along with my solicitor John Smith, my partner Debbie, my two character witnesses Mike Moore (Chief Flying Instructor at the Devon School of Flying) and Alan Kelsall a fellow magistrate and friend. Alan also brought his wife Patsy along to give me moral support. Flying Instructor Steve Wells couldn't make it on the day but wrote a letter to the court explaining what a travesty of justice it would be if such an upstanding pillar of society were to be found guilty on such a frivolous charge.

The trial started and the CAA's first witness was Arthur Fry, Airtime Aviation's Chief Engineer. Although his written statement to the CAA said he had nothing to do with the application for the C of As, he had previously put it in writing (faxes to the Swedish CAA among others) that he thought at the time that the forms he filled out were applications for the C of As. I had telephoned him when this first blew up and when I told him that there was no C of A, his words where: "That's ridiculous, I can remember sending them [the applications]". The first thing he said on the stand was that he thought the forms he sent to Sweden were the applications for the C of A. I thought this was just what I wanted. The rest of the trial was somewhat academic until I was called to the stand. My solicitor asked me the usual questions, confirming that I was without fault in all respects, a fine man and summarily polished my halo. The CAA barrister then started at me and, after wading through a lot of questions aimed at making me seem lazy and uncaring, his bottom line was. "You did not personally check that the certificate was actually issued?" This was asked of me so many times that my solicitor had to intervene to restrain this young and rather over-zealous lawyer before I invited him outside to discuss the matter man to man.

My two character witnesses, Alan Kelsall, and Mike Moore, both got up and confirmed my impeccable character and flying history. The letter from Steve Wells was also read out in

court.

The magistrates went out to deliberate. After what seemed an eternity they came back and I could see on their faces what the decision was. I know from my own experience as a JP that for it to take that long there must have been a split decision and the undecided JP had to be persuaded by the other two to go 'their' way to make the majority. The chairman was a quite pleasant man in attitude and appearance. The two female wingers were quite different. It looked like they took their dress code from Hyacinth Bucket and their facial expressions from a 1950's school teachers convention on 'the enforcement of discipline both verbal and physical'. Sure enough, they found me guilty. They decided I should pay a £3,000 fine and £3,200 in CAA costs. That was £6,200 plus my own costs of about £5,500. Almost £12,000 because I did not get the piece of paper.

Appeal

Very dark thoughts about 'bloody justice' crashed about in my brain. I was livid. Where could I buy a Kalashnikov to dish out some justice of my own! I demanded an appeal immediately, although I was advised I had 21 days in which to decide and it would be a good idea to calm down before making the decision to spend more money on legal fees and barristers trying to overturn this 'mindless' decision. One week later we lodged the appeal.

I had to wait until Thursday October 16th 2003 for the appeal. This time it was in Dorchester Crown Court. It quietly crossed my mind that there is a prison in that town...

The date arrived and we duly turned up in Dorchester Crown Court at 10:00 ready for the appeal at 10:30. It was approaching 12: 00 by the time we got in court and started. The appeal was very similar to the trial at the magistrates' court except we had a judge with two magistrate wingers.

We went through the whole process again as if it had never happened before. There was one important difference though. This time Arthur Fry decided to say that he did not have anything to do with applications for C of As and the forms he sent to Sweden were the maintenance forms. He was put in his place by my barrister who pointed out we had it in writing that he thought they were applications for the C of A, but nothing would stop him trying to dig a hole for me to be thrown in. Thanks Arthur, I hope your conscience is clear. I just wish my barrister had asked him why he had changed his story since the magistrates' court.

It was my turn on the stand after lunch and it was much the same as before. My barrister asked me questions confirming what a fine man I was followed by the CAA man (same one as last time, his name is Jones too). He uses the same method as last time, going on and on asking the same question, actually more like a statement telling me I did it on purpose and I just didn't care. Again the only way to stop him was for my barrister to stand up and point out that I had answered his question. I was ready for him this time and did not show one ounce of anger, just answering his question calmly over and over again.

The judge was quite good asking relevant questions, which gave me confidence that he understood the circumstances. The bench retired to consider their verdict. This time only about fifteen minutes passed and they were back. The judge then spent about ten minutes giving a résumé of the case before getting to the guilty or not guilty bit. Alas, his words were something along the lines of 'a little too little and a little too late'. Again disbelief washed over me while the bench went out to decide sentence. This took about two minutes! They must have already decided because their decision was a conditional discharge for 12 months, no fine and only £1,000 towards the CAA costs, leaving them something in excess of £3,500 out of pocket.

"You have seven days to produce your pilot's licence, CofA and insurance. And by the way, do you know you have a tail light out?"

Technical Offence

A lot more like it, I think. Still not 'not guilty', but not worth spending more money on another appeal. I was actually £5-6,000 better off than I was before the appeal. Over the next few days I felt much better about the whole thing. The judge's reasons said it all: "We consider that the appellant had been cooperative throughout and did his best to rectify matters when he realised that he was in fact without an airworthiness certificate. There is no chance of repeat offending. His only real fault was to delegate his responsibility to an apparently respectable aviation company. A fine was not justified for what seemed to be a technical offence."

On the day, the judge told me that my error was to leave it up to the maintenance organisation to arrange everything. I should have checked that the certificate had in fact come back from Sweden, and not taken their word for it that the plane was OK to fly. In other words, it is not good enough in court to say you have been assured that all is well before you fly; you have to personally check all the documents.

Conclusions

Do you check the airworthiness certificate before you fly in a hired aircraft? Maybe you should….

Some points I would like to make:

- The CAA is now the only authority that does not refer its prosecutions through the Crown Prosecution Service (CPS). Had the CPS reviewed my case, I am sure they would not have interpreted this rule so literally.
- Had a similar case come before the CPS regarding a car owner who had had an MOT inspection but had not received the certificate, the owner would have been given the opportunity to obtain the missing piece of paper.
- The CAA seems hell-bent on justifying their legal department's existence by resorting to the courts for any minor infringement. Just read the GA press for other examples.
- Although the CAA said they wanted around £4,500 to cover their costs bringing this case to court they were only awarded £1,000. Also, the CAA get their costs paid by general taxation so do not need to charge such high costs. It's just a means of increasing fines even further. This £1,000 is still a great deal more than the CPS ever inflict on their miscreants.
- The only people to benefit from this case are the lawyers. The CAA was not awarded £3,500 of their 'costs' and I am £9,000 light. £9,000! I hope the CAA thinks they have improved air safety (or whatever?) by doing this. Was all this really necessary? I think not.
- I now have a criminal record. Yes, a criminal record that will stay with me mentally for the rest of my life and that I will have to disclose it to those entitled to ask for the next eleven years until the Rehabilitation of Offenders Act kicks in. The term 'of previous good character' will no longer be a phrase that can be used to describe Len Jones.

Disorientation at low level can kill you in a trice

By Nigel Everett

> In a turn at night it is quite easy to lose your perception of angle of bank where there is no defined horizon

During the evening of Tuesday November 12, 2002, a pilot of a Mooney M20R carried out a VOR approach to runway 06 at Vineyard Haven, Massachusetts. The weather conditions included visibility of two miles in heavy rain and mist and a broken cloud ceiling at 600 ft. He broke off the approach at 200 ft AGL and continued, apparently in accordance with the missed approach procedure, in a climbing turn to the right. At 700 ft AGL radar contact was lost and shortly afterwards the aircraft crashed into the Atlantic Ocean.

The pilot was a 350 hr PPL/IR and he was on an IFR flight back to his base at Vineyard Haven from Florida, where he had been visiting friends. There were no radio calls to indicate any trouble and no significant parts of the aircraft were recovered. The National Transport Safety Board (NTSB) cited the probable causes as: *The pilot's spatial disorientation during a missed approach, which resulted in a loss of control, and the airplane's subsequent impact with the water. Factors included clouds, rain and night lighting conditions.*

Few Visual Clues

I have drawn attention to this sad story because it has many of the classic ingredients to be found in occurrences of spatial disorientation. Visual flight at night, with few visual clues, as might be found over the ocean at night in two miles visibility, is very likely to lead to disorientation, especially where the pilot is trying to fly by these clues instead of sticking exclusively to the tale that the instruments have to tell. I can vividly recall turning on to final during a visual night circuit after a long and tiring flight and suddenly realising that I had inadvertently reached an angle of bank of nearly 90 degrees. In a turn at night it is quite easy to lose your perception of angle of bank where there is no defined horizon and of course I should have been monitoring the attitude indicator in the turn. If I had continued rolling for about another second I might well have reached an attitude from which recovery would have been impossible from my height of about 500 ft AGL.

Where there are some visual clues it is all too easy to rely on them on a missed approach from an attempted instrument landing rather than getting back to solid instrument flying. We shall never know just how everything went wrong for this pilot. Did he move his head significantly in the turn, thus increasing the risk of disorientation by way of Coriolis effect? Did he forget his scan while re-programming his GPS for another approach? Alas, we shall never know, but there seems little reason to argue with the NTSB conclusion because these were just the right conditions for spatial disorientation to occur and there had been no indication of any sort of difficulty beforehand.

Virtual Invulnerability

With the heavier metal at controlled airports there are often better clues as to what happened. A Socata TBM 700 single turboprop piloted by a PPL/IR out of Centennial Airport, Englewood, Colorado in March 2001, for example, was in radio and radar contact shortly before it crashed after take off in IMC. Here again, the NTSB has determined the probable cause as: *the pilot's spatial disorientation, which led to his failure to maintain aircraft control….*

In this case, the pilot seems to have done all that should be done pre take off, except, perhaps, to decide not to attempt a take off at all: *into known adverse weather that consisted of low ceilings, obscuration, and ice fog.*

He had his aircraft placed in a preheated hangar for an hour before taxiing out. He was meticulous in his checks and ran the engine up for 20 minutes at high revs. He took off on an IFR clearance at 0718 and at 0719:27 he called, *lookin' for higher.* The airfield controller had his primary return on radar and instructed him to fly the runway heading and contact Departure Control. He never responded. The radar tracks show that the aeroplane began drifting to the left of runway centreline almost immediately after takeoff. It made a climbing left turn, achieving a maximum altitude of 1,200 feet AAL and completing 217 degrees of turn, before beginning a descending left turn and crashing only ¼ of a mile from the airport.

This pilot was 49 years old with over 1,000 hours. He had undergone recent Instrument checks and had received a Pilot Proficiency Award from SIMCOM seven months before the crash. In passing, I would comment that this also seems to me to be a classic case of someone with new qualifications and/or new equipment imagining that they have now reached a stage of virtual invulnerability from mishaps. In the same fashion, new owners of cars with ABS braking often conceive that they need no longer make any allowance for slippery roads.

P 14 ▶

Flight Management Systems

In the June/July 2002 edition of Network, the forerunner to Instrument Pilot, A.P.R.Gibbs and J.W.Smeltink presented an article comparing the use of GPS and DME in terminal airspace. ***Ed Follett****, a PPL holder and electronics engineer with Smiths Aerospace in Cheltenham describes how the Flight Management System as used in the B737 operates and explains why it should not be dismissed so readily.*

There is a misconception regarding Flight Management Systems: They are not and never will be the sole system responsible for navigation and performance control on the aircraft. That responsibility will always remain with the pilot. Flight Management Systems have been developed to fulfill two main tasks. First to reduce pilot workload by integrating other systems and second to save the operator money. Flight Management Systems, when operated within the "normal" environment will save on average upward of 6% between city pairs when compared to non-FMS operations. There is also a 2.5% flight time saving thrown in. In real terms this can represent significant cash benefits over a relatively short period of time.

The Flight Management Computer (FMC) is at the heart of the FMS and can be viewed as an electronic version of the pilot's flight bag. In it are contained all the necessary navigation charts and plates together with the flight computer (E6B) plus the performance section of the aircraft operating manual.

In engineering terms it is not a complex system. Smiths manufacture the FMC, Control Display Units (CDUs) and Auto-throttle. All other components such as the IRS, Common Display System or EFIS and auto-pilot (AFDS) are made by other companies.

Operationally, the FMC simplifies the pilot's task of operating the aircraft. It does this so well that with a little training and understanding I could teach someone with little or no flying experience how to use this system in a couple of hours (I could fly a 737 simulator long before I had my PPL but that's another story!)

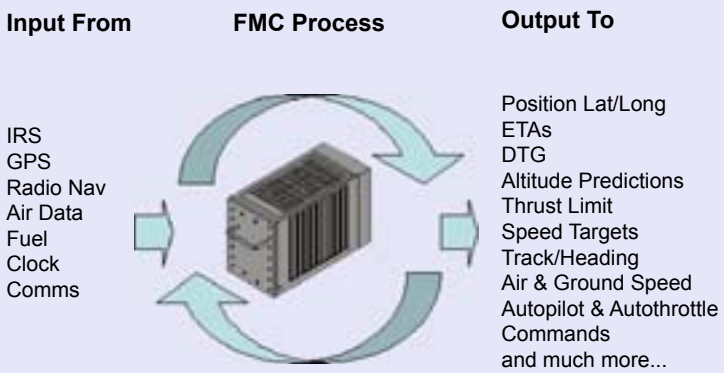
The way in which it works is fairly straight forward. Just like any other computer it takes the inputs, washes them around a process and provides an output (see fig 1). So we input a multitude of sensor data: IRS, Nav Radios, GPS, Air Data, Nav data, Aircraft state and many others to provide a system position, speed and altitude targets, engine limits and many, many more solutions. The most important one is the system position. See page 20 for an explanation of the finer points of FMC function.

The point to note here is that the FMC manages all the sensors automatically and will use whatever is available. However, the FMC only requires one IRS in Nav mode for it to work, every other Nav sensor input is a bonus but the more sensor inputs available the more accurate and reliable the FMC position solution becomes. It does not update the raw IRS position; in fact it cannot update the IRS at all as the nature of the IRS will not permit any attempt at resetting once the unit has been aligned and is moving. Also, GPS is still an option on many 737s and in

P 14 ▶

Ed Follett *is employed by Smiths Aerospace as a technical instructor for customer training. This includes several systems and equipment, one of which is the Flight Management System fitted to all Boeing 737s from the -300 onwards. He has been involved with this program for the past 14 years and teaches the equipment from system (aircraft operational and maintenance) level down to component level for repair technicians. He is therefore rightly regarded as a point of reference for all things (Smiths) FMS*

Fig 1. The FMC Process



FMC Position Determination - An Analogy

Walk the Centre line (track) of a football pitch with your eyes closed for 60 paces. Stop – providing you haven't walked into a goal post that puts you way off track, it is unlikely that your position will be on track (i.e. you are not where you imagined you would be). Any errors can be attributed mainly to your balance (IRS). Now repeat the task only this time open your eyes (radio sensors) for a fraction of a second every 10 paces you will be able to track the line very easily. Your brain (FMC) is processing the information from its balance sensors and uses other data to constantly correct, automatically, any errors that may occur in your own position determination. The FMC works in much the same way and uses sensor data to update the position information it receives from the IRS to provide the system position. *Now try walking the center circle using the same method*

some cases where the GPS has been fitted it may not be linked to the FMC. In fact it wasn't until the early '90s when the FMC software could accept a GPS input and later still before the system could use a GPS input in its position solution.

The complexity of the system is invisible to the operator. Position determination and down track predictions for ETAs and fuel burn are based upon real time sensor data and are constantly reevaluated to take into consideration changing and unexpected conditions. Only if and I stress IF the system detects an error it cannot resolve, will the FMC throw its hands up and run away to hide in the deep recesses of the electrical compartment. The pilot has to then earn his money in determining where exactly they are. Unless the crew handles the situation in the wrong way the aircraft will not fall out of the sky.

The accuracy and reliability of the system depends on the aircraft hardware, the FMC model number and of course the software. All this has evolved over the years to reflect the advances in digital technology and operational requirements.

Flight Management Systems are still evolving and will continue to do so as long as there are improvements in aircraft operation and air traffic control to be made. The B737 FMS program has expanded to cover other aircraft. Although on some aircraft the FMS function is part of another "black box" provided by another manufacturer, the hardware and software which provide the FMS function is Smiths and very similar in operation to the B737.

In conclusion the B737 FMS is simple to use and provides real time benefits to the crew with significant cost savings and increased flight safety.

Ed Follett
Senior Technical Instructor
Smiths Aerospace

For a description of how the B737 FMC system operates, see page 20 ►

FANS (Future Air Navigation System - Automatic Traffic Management incorporating Communication Navigation and Surveillance- ATM /CNS)

FMS are useful for operation within a FANS environment where each phase of flight is given a required navigation performance (RNP) value expressed as a distance in Nm. The position estimate must be within the RNP radius with a 95% certainty. The RNP value is normally fixed for any particular phase of flight, but can be overwritten by the crew. The expected performance will have accuracy dependent upon its current measurement set. This measure is the actual navigation performance (ANP). It is based upon the number of sensors available and how long they have been used in the system solution. Expressed as a radius in Nm, the user can be 95% certain that the actual position is within that distance from the system position as calculated by the FMC i.e. at any point in time the actual position is 95% certain to be within the ANP distance.

TYPE OF UPDATING	SINGLE FMC	DUAL FMC
MULTI DME		
Scanning receivers		
8 DMEs	NA	0.10 – 0.12 nm
4 DMEs	0.13 – 0.15 nm	0.13 – 0.15 nm
Non Scanning		
4 DMEs	NA	0.16 – 0.18 nm
2 DMEs	0.20 – 0.24 nm	NA
DME / VORs	0.30 – 0.35 nm	0.21 – 0.25 nm
All receivers		
GPS		
Bad Geometry	0.20 – 0.24 nm	0.14 – 0.17 nm
Good Geometry	0.06 – 0.08 nm	0.04 – 0.05 nm

Representative ANP values for single and dual systems

Each of the navigational performance errors shown in the table is for that type of system alone: Combinations would approach the smaller ANP of the two. More measurements translate into better performance and combinations such as GPS with DME provide extra information needed to have high confidence as well as high accuracy. The most robust is therefore a dual FMC with Dual scanning receivers and dual GPS.

The net result of such a system is that position accuracy is virtually guaranteed. And with data link all aircraft within the airspace know the position of all other aircraft. Separation can therefore be reduced thus increasing capacity and smoothing traffic flow. Other benefits include greater reliability, shorter flights, on-time arrivals, lower fuel consumption and, last but not least, increased flight safety.

Misleading Senses

The further up the IFR aircraft food chain you progress, the more information you get about the cause of accidents when they occur. A Learjet 25 on a cargo flight out of Tompkins County Airport, Ithaca, New York, took off at night in fog with less than one-mile visibility. It crashed half a mile from the departure end of the runway virtually on the runway extended centre line. The Cockpit Voice Recorder (CVR) and the Flight Manual between them convincingly tell the probable story and show how NTSB concluded that the probable cause was: *The pilot's failure to maintain a proper climb rate while taking off at night, which was a result of spatial disorientation. Factors in the accident were the low visibility and cloud conditions, and the dark night.*

The CVR shows that the two-man crew was going through the usual after take off checks in an orderly manner until the aircraft was flown into the ground. The Flight Manual warns: *Flying in instrument meteorological conditions (IMC) can result in sensations that are misleading to the body's sensory system... A rapid acceleration, such as experienced during takeoff, stimulates the otolith organs in the same way as tilting the head backwards. This action creates the somatogravic illusion of being in a nose-up attitude, especially in situations without good visual references. The disoriented pilot may push the aircraft into a nose-low or dive attitude.*

Only Defence

There is only one defence against disorientation and that is to stick wholly to what the instruments have to tell you and to ignore any sensations or half perceived visual clues. That's easily said from the armchair but much less easily done in practice. Most of us practice unusual attitudes just once a year at or just before our rating revalidation but we really should get up there more regularly with a safety pilot and screens or similar and practise so as to keep our defences against disorientation stout and dependable.

What does the EXECUTIVE COMMITTEE do?

By Paul Kelly

If you come to our meetings you will hear of some of the issues that the organisation, is working on, on your behalf. But no meeting can cover the full range of issues. To get a better understanding of the breadth of issues, consider what was covered at the most recent committee meeting on 16 November 2003.

The committee achieves its objectives through:

- sitting on various official committees;
- working with other aviation organisations – e.g. GASCo, AOPA (UK and Europe), GACC and the Royal Aero Club;
- attending workshops – including this year the Eurocontrol General Aviation Briefing Day, the Eurocontrol Focus Group on the Harmonisation of European Airspace, and the Eurocontrol Workshop on RNAV.
- communicating directly with key individuals in the CAA, Eurocontrol, JAA, EASA, and with equipment manufacturers and service suppliers.

The recent meeting covered the following areas: We discussed the adequacy of the current online NOTAM system, and agreed to seek further improvements. We talked about the availability of FAA flight training in the UK, which will in due course be put on the web site. We are also pursuing discussions on making the JAA IR ground school and licence renewals easier/cheaper. Jeppe Sørensen had recently attended a Eurocontrol conference on P-RNAV on our behalf, and had spent much time closely analysing the related official publications. He had found a number of areas where the practicalities or cost implications for general aviation appeared to have been overlooked. Whilst IFR GPS equipment can easily meet the accuracy requirements of P-RNAV, the proposed regulations introduce additional requirements that would be difficult or impossible for us to meet, such as:

- a mandatory slaved course selector,
- specific pilot training and certification will be required, though there is no plan to define the scope of the training;
- specific requirements on leg transitions, which do not allow for any pilot intervention, and some of which are not achievable with GPS only equipment;
- a fully updated database, probably on a 28 day cycle.

Roger Dunn has also been monitoring related changes affecting B-RNAV, and the worrying suggestion that BRNAV installations might need individual approval, including retrospective approval for existing installations.

References were beginning to arise to a previously unknown European document, JAR-OPS 0, which was described as 'a comprehensive code of general operating requirements … to be suitable for application to all General Aviation activity'. Clearly this might have a great impact on us, so we planned how to follow this up.

The CAA has issued a discussion document covering changes proposed to the Air Navigation Order, to come into line with ICAO standards. Jim Thorpe had studied the paper and the 15 appendices and highlighted the following proposals particularly affecting our members:

- oxygen must be used by crew above flight level 100,
- automatic Emergency Location Transmitters (ELT) must be carried when flying more than 50 miles from land, and over specified inhospitable terrain,
- precise weather minima must be satisfied if an IFR flight is to be made without an alternate destination,
- an apparent requirement to be continuously aware of the latest published weather information for the destination.

There was a brief discussion of how the web site could be given a fresh look as it would soon be coming up to its second anniversary.

There is a proposal that the UK should come into line with practice elsewhere in Europe with regard to engine life. The three specific issues here are:

- engine life could become limited on both an hours basis and a calendar basis (i.e. on absolute age, irrespective of hours flown);
- engine time may have to be calculated from start up to shut down, not take off to landing;
- there may in future be no extensions to nominal engine life – i.e. no 'on condition' extensions.

Anthony Mollison is developing a one-day training programme for PPL/IR Europe members, which specifically addresses the needs of private pilots. This is likely to include presentations/discussions on flight planning, icing, cockpit resource management and some time on the most up to date FNPT2 simulator, practicing problems and emergencies that cannot reasonably be covered in real flights.

A subcommittee was formed to consider how the organisation could increase the scope, quality and effectiveness of the service it provided to members.

This shows just how much work is going on in the background, somewhat out of sight of the members. Face to face time in meetings is supplemented by considerable research time to ensure that we have a complete grasp on the topics we are discussing. I personally spend less time than many committee members, but even I average 1,700 emails per annum on PPL/IR Europe business.

We try to keep you informed through detailed articles in Instrument Pilot and on the web site but inevitably, writing these articles takes more of the time of those who are also trying to achieve results.

Please consider stepping forward to help out and share the workload so that we may achieve more. If you are an expert in some relevant area that is great, but specific expertise is not essential.

Some of the topics mentioned are dealt with more fully in the forthcoming issue of Instrument Pilot.

By
David Bruford

Class E Airspace

If you've followed the talk about FL Z you will know that below this level, whatever it is going to be, no IFR will be available except in controlled airspace. The level is to be set at FL195, FL95 or FL75 dependent on what you read. But if any of these are selected and you are rattling along in uncontrolled airspace below FL Z solid clag, a RAS would not be available to you because you can only get a RAS in IFR. I made a proposal that SIFR (Special IFR) be created and a few others made similar noises, but more in humour than hope.

However, propositions are being heard within Eurocontrol that aircraft that require IFR outside of CAS could be granted Class E airspace. Unlike airspace that resides over a geographical area, Class E would surround an aircraft to some, as yet, undetermined size, and travel with it making it eligible for a RAS. This would be great for PPL/IRs but might lead to an amusing scenario.

Imagine that you are on the apron at Exeter and call up ready for an IFR departure to Liverpool. ATC replies granting you taxi clearance and creating your Class E airspace. In the next breath they castigate the poor pilot parked next to you who was just about to request a VFR departure to do some circuits, for being in controlled airspace without permission.

Aviation legislation, when created, has a history or being very precise. Would Class E airspace be a circle, based around the centre of the aircraft, or the pilot? Alternatively it could be square so that it could fit into a hangar. Better still it could be a star so that when it shows up on the radar screen it could get a clear priority as befits our rating.

ATS route designators changes

For all of you that enjoyed the chart changes that descended on you in November, you will have more fun to enjoy in March 2004. The following ATS route designators will change within UK airspace on 18th March 2004 and be notified through a 'double AIRAC' cycle: B10 will be re-designated to L175; UB10 to UL175; B39 to L18; UB39 to UL18; UG4 to UN160; UG45 to UM142; R14 to M17; UR14 to UM17; R37 to M140; UR37 to M140; UR40 to UL739; UR116 to UM25.

Don't go without a PLB

There is a current recommendation that members refrain from purchasing 121.5Mhz PLB (Personal Locator Beacon) devices which are currently widespread on the market, since 121.5 Mhz will become obsolete in a few years. It is therefore recommended not to purchase such transmitters until the future specifications are made clear. However if the choice is to fly with a 121.5 PLB or no beacon at all I suggest that you beg, hire or borrow a hand-held PLB if your flight is liable to take you over water or terrain where a search would be aided by a beacon.

Don't see and still avoid

France based member Roger Drinkel is pretty impressed with the way that the French aviation authorities are jerking their knees to prevent terrorist from attacking their nuclear power installations. Naturally the most likely threat will be from the ramming of such solid concrete structures with very light aluminium aircraft, so this is where the precautions should be imposed.

Roger warns that the nuclear installation restriction (and the penalties for infringement) apply to every nuclear power station in France and has heard of one German pilot in a DR400 that flew over Bugey - a nuclear site near Lyon who was tracked down by the military at Valence - 60nm (30 minutes) later!

He also comments: "If the French government need all this spacing for safety, the logical thing is to impose a forbidden area 120nm in diameter going up to at least FL 200. Perhaps they should rethink 'simplified air space'! That being said, France is still the best and lowest priced country to fly in Europe. What a shame, as in many other things in France, they are throwing away the good things and becoming as stupid as their neighbours.

It is interesting to note that flying IFR, arriving at Orleans St. Denis de l'Hotel (my base), at transition altitude, the controller tells me to "Descend to safety altitude - no IFR traffic to report". In IMC, this can mean 2100ft above a nuclear power plant. Are we supposed to have so much situational awareness to know where all the nuclear plants are while in IMC? They aren't shown on IFR charts. Perhaps they reason that if we can't see it, we can't hit it!! What happens if we come out of cloud at the last minute and see it?"

Logic, has never been at the forefront of any authorities thinking when it comes to knee-jerk reactions.

Chairman's correction

Flight Level Zulu

In IP41 article " FL"Z" & PRNAV" I regrettably inferred Eurocontrol were one of the "...powers that be..." proposing FLZ be set at FL195. That is not the case in that they are proposing it is at FL95. The CAA has been proposing FL195, which we regard as far too high.

Paul Draper

Wings Around the World

As a result of the PPL/IR Europe's Saumur trip that resulted in a donation of £550 to Polly Vacher's charity "Wings Around the World", our Chairman, Paul Draper, received the following letter.

Dear Mr. Draper

It was such a lovely surprise to receive your letter and simply wonderful donation for Polly's "Wings Around The World" fund for Flying Scholarships for the Disabled. Thank you all so much for this very generous donation.

I managed to get through to Polly yesterday evening. You may know she is still stuck at Ushaia waiting for the weather to become favourable and this is a very hard time for her as you can imagine. She was so delighted to hear of your kind generosity and it really gave her spirits a lift when she most needed it. It will be so good for her to get this part of her trip over, as it does seem to be the most daunting. She has now been flying, talking and spreading the word for seven months gathering money for the cause and perhaps just as important heightening people's awareness of the fact that the disabled can fly just as well as the rest of us, given the chance!

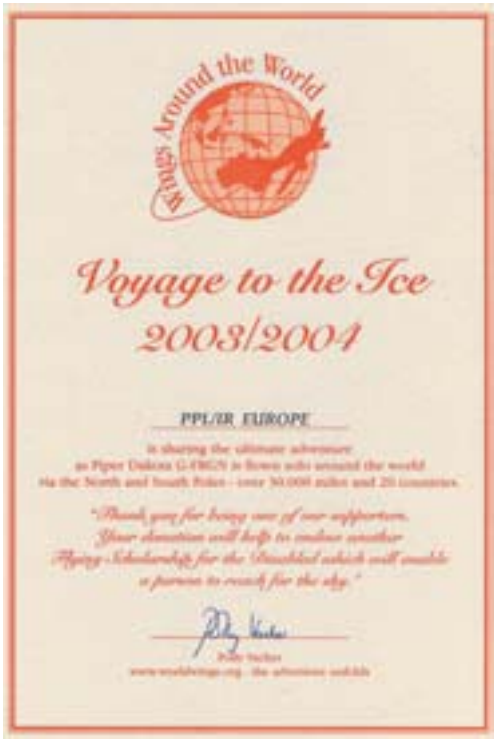
Would you like to have PPL/IR EUROPE put on the wing of Polly's aircraft? It would have to go on when she is in Australia, if this is possible. Do please give me a ring as soon as possible if you want this, but anyway I shall be sending you a signed certificate and for that I shall need to know whether you would like the wording as above or in some other way?

Polly personally asked me to write to thanks all members of PPL/IR Europe so very much indeed for this wonderful donation, you have helped cheer up her waiting days.

With all best wishes

Rosemary

Rosemary Taylor (Polly's Team member)



And from Polly herself...

Dear PPL/IR Europe members

I am sitting in Ushuaia, patiently waiting for that golden weather window which is slow to rear its head! I never was patient - so this is good training!!

I have just had a phone call from Ro (Rosemary Taylor) to tell me the wonderful news that as a result of some money left over from a PPL/IR weekend a generous cheque for £550 has winged its way to Flying Scholarships for the Disabled. That is so generous and we are all so excited and thrilled with your support. Please thank all those involved on my behalf.

Ushuaia is a beautiful place situated in the foothills of the Andes on the Beagle Channel. The people who live here match the beauty. The warmth and loving kindness of the Argentinean people is quite overwhelming. I have also had a lot of support from the yachting community and have met some amazing people who have sailed around the world - wintered over off Ellesmere Island in the Canadian Arctic and a whole host of unusual things. The Aero-Club of Ushuaia is so friendly and helpful too. Nothing is too much trouble in spite of the language problem (I am taking Spanish lessons!) How about a PPL/IR fly-in to Ushuaia??!!

Again, a huge thanks from us all for your wonderful support and that of the members. Hope to see you soon.

With love

Polly Vacher

MEMBER 292

Polly Cacher's website can be found at www.worldwings.org. *Details of Ushuaia can be found at http://www.pj201.co.uk/S_America/Ushuaia/Ushuaia.html. If you are considering a jolly it's about 210° out of Exeter; 7093.6nm.*

My first real IFR flight

Most enjoyable! I just wanted to share my feelings on this to help others either remember their first time or to hear what they have to look forward to.

In November, thanks to a friend who has ATPL/IR both JAA and FAA as well as instructor ratings in both, I had a very enjoyable flight in the soup and gunk from my home base at Cranfield down to Southend and back today. My first real IFR flight, albeit non-airways (rather than just IFR in VMC or simulated IMC with the screens or foggles)... it was solid IMC for the whole flight both ways, and I thoroughly enjoyed it! Originally the flight was supposed to be to Norwich and back, but the solid IMC and lack of Navaids in East Anglia kind of threw that plan out the window since my little Arrow does not have de-icing capability and to pick up decent Navaids I would have had to be at least FL050 where in the soup it would have been potentially icing conditions... so we chose Southend instead.

Departure EGTC was fairly uneventful, right turnout off 04 climbing into the murky rain. Luton was busy, so got radar information and passed down the corridor between Luton and Stansted. It was very bumpy at one point, and the workload was very high... but I eventually managed to get it sorted. I found it really hard keeping heading and height in the moderate turbulence from the two weather systems colliding head on straight across the zone, but was a great learning experience. I did feel somewhat

P 18 ▶

nervous for this one, as it was my first real IFR in real IMC flight, albeit with an instructor... so I was nowhere near as relaxed as I could have been. We got a radar vectored ILS approach into Southend and the first approach aborted by ATC due to traffic crossing the final approach path, so was instructed "for avoiding action turn left 180 degrees" and was re-vectored back around for another successful shot.

After lunch and a couple of coffees, it was back to Cranfield. Departing runway 24 climbing into the soup then direct to Lambourne. For the return, I was considerably more relaxed. The turbulence wasn't quite as bad this time going through Luton's zone, though it was still quite significant at times. I did, however, manage to keep the altimeter and DI more or less nailed to the numbers throughout the flight. Finally approaching Cranfield, for once (I think the first time ever for me) the ILS approach was smooth with zero turbulence (which is unusual for Cranfield), landing on 22 with a slight tailwind. I'm now VERY much looking forward to the rest of the long trek to the I/R and can't wait to do this again!

Leland Vandervort
MEMBER 586

Help recruit new members!

PPL/IR Europe does not have a large advertising budget to promote itself and gain new members. Although we do run some limited advertising in the aviation press, we mainly rely on word of mouth.

However, this could be extended to a poster campaign if members would help us. We have produced an A4-sized poster shown right, and the aim is to hang it on the notice boards of every IR flying school and General Aviation airfield across Europe.

Rather than sending copies of this poster to all members, we are going to ask you to download the poster from http://www.pplir.org/pdfs/Poster%20Campaign.pdf on the www.pplir.org web site. Then please print that file in the best quality your printer can muster and hang copies in appropriate places and hand out copies to others to do the same. Ideally the print should be laminated if you can, both to make it look better and to make it last longer. If you don't have Internet access phone or write to David Bruford (details on page 19) and he'll send you a laminated poster by return.

Sorry - no prizes, except the satisfaction that you are helping us to grow and become stronger in the interest of every General Aviation IR pilot in Europe.

Many thanks
Ole Henriksen
Membership Secretary

PPL/IR EUROPE

gives private instrument rated pilots across Europe access to the sharing of information and experience on instrument flying that is a natural part of a professional pilot's working environment, but is hard to find for private operators.

We also campaign for pilot-friendly IR legislation in Europe, and in our bi-monthly journal, *Instrument Pilot*, members discuss every aspect of instrument flight, regulations and equipment. Meetings are arranged several times a year offering both flying related and social contents.

For more information and enrolment, contact the Membership Secretary on +44 (0)1481 25 25 65 or visit our web site at

www.pplir.org

PPL/IR EUROPE

G-GUYS - Piper Seneca PA34 – 200T. Serial Number 34-7870283. Manufactured 1978. Certified 1,999 kilograms. Total time - Airframe and Engines 2119. Port Prop 1203 Notice 75 (6 year) May 2001. Stbd Prop 835 Notice 78 (3 year) May 2002. C of A Private to May 2005. Original Paint; White/Blue. Interior - Club Seating, Blue Velour. Fully De-Iced. Long range tanks. Factory corrosion proofed avionics. Audio/Markers KMA 20. No. 1 Comm/Nav King KX 165. Glideslope FM Immune. No. 2 Comm/Nav King 175B Glideslope. ADF King KR 85. DME King KN 65A. u/s Transponder KT 76 with mode C. Intercom Sigtronics SPA 400HSI NSD 360. Autopilot Century Altimatic 3C Coupled Glideslope. Dual Altimeters. Electric Trim. External Power Socket. Asking price £55,000 no VAT. Contact Roger Keel - 01522 731761. E-mail: evenkeel@onetel.net.uk

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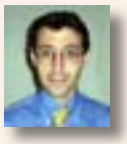

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PPL/IR EUROPE

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B737 FMC System Position Solution

The purpose of the FMC is to provide position data to the crew and other sub systems. Note that the calculated FMC position ("**system position**") is where the FMC (aircraft) "thinks" it is and as such this ***may not*** be the actual position but one which is an average of all available sensor positions (Fig 2). The B737 FMC thus determines its position from various navigation sensor inputs.

The primary source of navigation is provided by the Inertial Reference System (IRS). FMC navigation operates by modeling IRS errors. It accepts latitude and longitude from GPS, slant range from DMEs bearing data from VORs and cross track deviation from ILS (in any combination). Corrections are added to the IRS position to provide the system position and it is the system position that is used for all down track predictions based on real time sensor information and aircraft performance.

The FMC receives inputs from GPS, DME, VOR, TACAN and ILS to update its measurements of errors for the reference IRS. These measurements are validated against the predictions of the system model as to where in the real world it is and cross-referenced against the stored navigation database (NDB). This screens "bad" inputs from causing erroneous estimates from the raw input data i.e. the FMC rejects bad data from an individual sensor if that data does not compare favorably with the others.

The position checks are matched to specified levels for the area navigation requirements for the current phase of flight (oceanic, en-route, terminal and approach). The comparisons are detailed in the table below. The criteria show a distance threshold between all sensor positions, and the time each criterion must be exceeded by, before a crew warning is issued. Note that the quoted figures are the maximum allowable error before a warning is given – the actual performance (ANP) is normally far less.

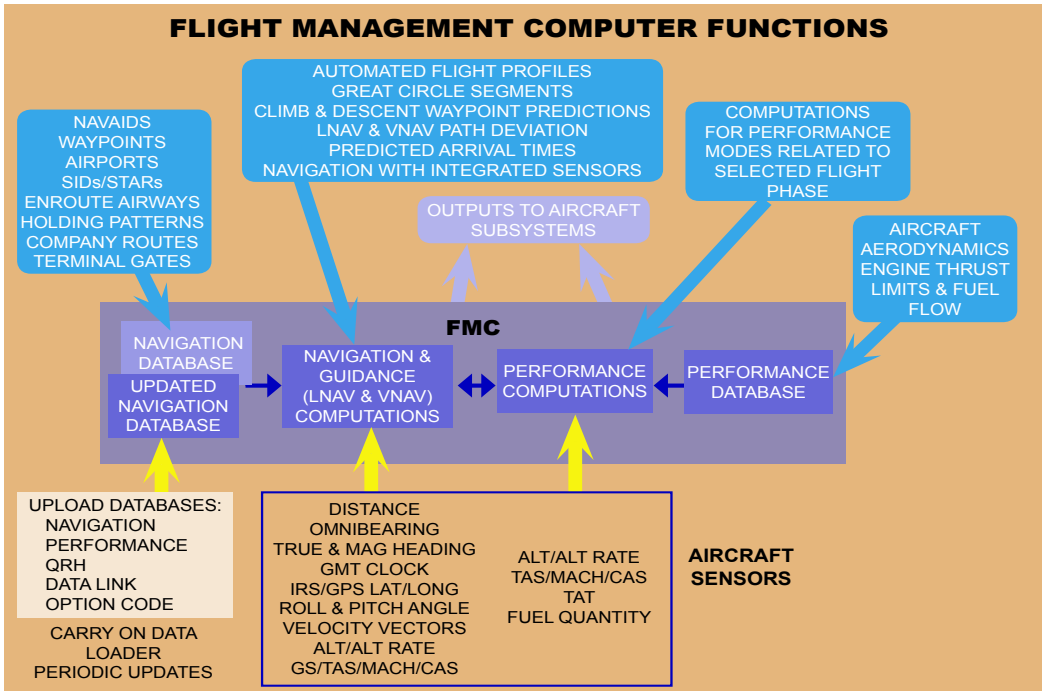
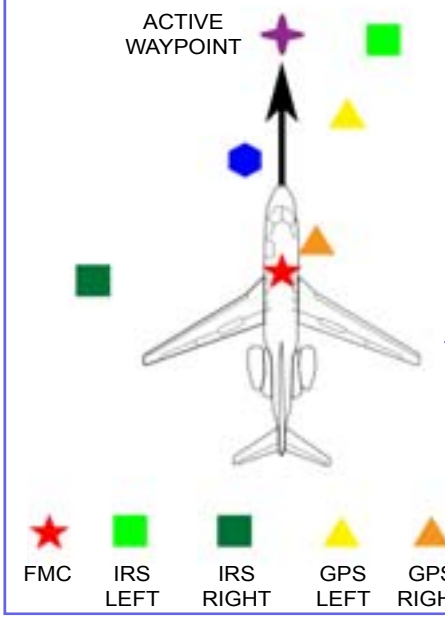


Fig 2. Relative Sensor Position (Plan View)
(Single FMC)



At initialisation, both IRS positions and FMC position will be identical. The plan shown is typical only after a period of flight when the system has been allowed to calculate errors

TEST	THRESHOLD	TIME DELAY	PHASE OF FLIGHT
IRS / IRS	>10NM	40 SEC	ALL
RADIO / IRS	>4NM	150 SEC	ALL
RADIO / FMC	>2.8NM >1.7NM >0.5NM	150 SEC 60 SEC 10 SEC	EN-ROUTE TERMINAL APPROACH
IRS / FMC	>10NM	40 SEC	ALL
ONSIDE TO OFFSIDE (DUAL FMC)	>2.8NM >1.7NM >0.5NM	150 SEC 60 SEC 10 SEC	EN-ROUTE TERMINAL APPROACH
GPS / FMC	>2.8NM >1.7NM >0.5NM	150 SEC 60 SEC 10 SEC	EN-ROUTE TERMINAL APPROACH

Map Shifts

A map shift, observed as a jump in the navigation displays, is the result of the FMC resetting the system position and manoeuvring the aircraft under L and V Nav to that position to a more accurate position as determined by the sensor filter process. This reset is more likely to occur – if at all – after long periods without any sensor updating. Any position reset that requires a shift greater than the distances listed above results in a position uncertainty, which is annunciated to the crew by the "IRS NAV ONLY" or "VERIFY POSITION" scratch pad messages. Either message will require some crew action to rectify the situation, normally a manual position shift. The issue of map shifts is somewhat complex but in general terms an automatic map shift is not an FMC fault. A manual map shift requirement has been virtually eliminated but may occur as a result of an error with two or more sensors providing comparable erroneous data.