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In this issue

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Editorial

During takeoff, many problems could arise like engine malfunction, engine fire, aircraft system failures etc., which could force the crew to a rejected takeoff (RTO) with a possible a runway overrun. In many cases, the outcome has been an accident damaging the aircraft and loss of life.

RTO is part of pilot's life, even though one may experience it once in decade. Each take-off includes a possibility of a RTO. In this issue, we look into this subject and the Go no-go decision which is crucial for safety.

On the technology front, we look into the Boeing's Global positioning Landing system (GLS) which slowly but surely will replace the vintage ILS System.

As always, we look forward to your feed-back, suggestions and contributions which can be sent to our office address given in this page. Happy reading and many more safe landings.

To Go or not to Go

Dr.M.S.Rajamurthy

On July 6, 2004 at Schiphol (AMS/EHAM) Amsterdam Netherlands, a Lockheed L-1011-385-3 TriStar 500 experienced compressor stall and surge during takeoff roll (probably near V1). Four extremely loud bangs came from the aircraft, and fire started coming out of No.1 engine. The captain did a RTO and managed to stop the TriStar before the end of the runway. All eight tyres of the main landing gear burst and there was severe damage to the brakes (see pictures below). Fortunately, there was neither fire nor injuries to the passengers onboard.

On Dec. 20, 2008 continental Airlines flight 1404, a Boeing 737-524, on a scheduled flight from Denver to Houston, crashed while attempting to takeoff from runway 34L. 110 passengers and 5 crew members were onboard. During its takeoff roll, the aircraft veered to the left, exited the runway, went down a ravine, and caught fire. 38 occupants were injured, 5 critically.

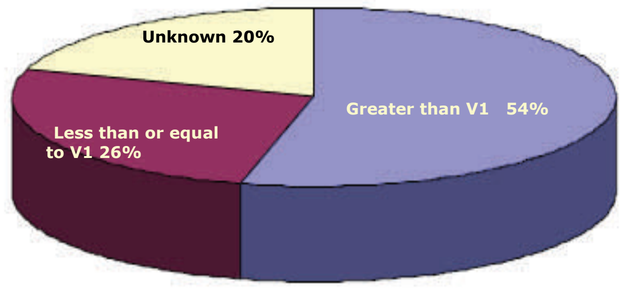
According to the US NTSB investigating the accident, FDR data showed that twenty-eight seconds after the brakes release, one of the pilots stated that take-off power was set. Forty-one seconds after takeoff, bumping and rattling started and that continued through the end of the recording. Four seconds later, i.e. at forty five seconds, one of the crew members called for RTO as the aircraft kept building speed down the runway. He noticed trouble at a speed of around 90-knots, but the plane kept accelerating to 119-knots. While the crew was braking, the aircraft veered off the runway, travelled down a ravine and caught fire. Tire marks were spotted at the 1,900 feet mark on the runway, some 700 feet before the plane veered left off the runway. The aircraft suffered severe structural damage due to impact and the fire around the right rear fuselage(see the picture on page 2).

These are two examples of the outcome of

Flames emanating from engine no.1 © Jacob Dahlqaard Kristensen/airliners.net

Burst tyres of the main gear © Miquel Snoep/airliners.net

Crashed Continental B-737



RTO Overrun Incidents/Accidents Initiation Speed (based on 94 RTO overrun accident/incidents from 1961-1999) Boeing data

RTO. Takeoff is a critical phase during which accidents can occur. Last year 9 out of 19 major accidents that occurred were during takeoff. In this, four were runway excursions including the Continental Boeing 737.

Each takeoff includes the possibility of a RTO and the associated problems resulting from the actions taken during the RTO.

Statistically speaking, a long-haul pilot flying an A340 or a Boeing 777 may face an RTO situation only once in 20 years as opposed to a short haul pilot of an A320 with 30 takeoffs per month who may see an RTO every 7 years. Unfortunately, in either case, the pilot must be prepared to make an RTO decision during takeoff.

Boeing study of RTO accidents and incidents revealed that:

- More than 50% of the incidents/accidents reported were initiated from a speed in excess of V1.
- About one-third reported occurred on runways that were wet or contaminated with snow or ice.
- More than one-fourth of the incident/accidents actually involved any loss of engine thrust.
- Nearly one-fourth of the incidents/accidents were the result of wheel or tire failures.
- Nearly 80% of the overrun events were potentially avoidable by following appropriate operational practices.

RTOs at low speed are simple maneuvers, associated with low risks, and rarely lead to runway excursions or to runway overruns.

High speed RTOs involve difficult maneuvers, and are of high risk due to the amount of energy involved, and the necessity to effectively control aircraft braking and the aircraft trajectory on the runway centerline. Runway over-runs or excursions mainly occur during high speed RTOs.

The statistics and experience show that, as soon as the aircraft reaches 100 knots, the safest course of action is to continue the takeoff, unless a major failure or a serious situation occurs.

RTOs performed when the takeoff distance is ASD-limited (Acceleration-Stop Distance) and rejected at V1, could be hazardous even if the calculation is correct.

It should be noted that near V1 aircraft will be rolling at 60-80 m/s at an acceleration of 4-8 knots/second. A two-second delay in initiating the RTO maneuver will lead to an increase in the stopping distance of about 250 m.

Operational standards

The decision of whether to STOP or GO, as well as the STOP action, are always performed by the Captain, as this decision and/or action may significantly impact flight safety.

The STOP or GO decision has to be made reaching V1, i.e. latest at the V1 callout. This emphasizes the importance of V1 callout.

The Captain must, therefore, keep his/her hands on the throttle/thrust levers until the aircraft reaches V1, regardless of whether he/she is PF or PNF.

If a malfunction or problem occurs during the takeoff roll, the Captain will call out "STOP", to confirm an RTO decision, and to indicate that he/she now has control of the aircraft. If the Captain calls out "GO", this confirms that he/she does not intend to reject the takeoff.

The takeoff roll is divided into a low and high speed segment. If the aircraft speed is below 100 knots, the aircraft is in the low speed segment and an RTO would be a low risk maneuver. If the aircraft speed is above 100 knots, the aircraft is in the high speed segment and an RTO decision may potentially involve more risks. The speed of 100kt is chosen to help the captain make his/her decision and avoid unnecessary RTOs at high speeds.

The factors influencing the STOP or GO decision-making process are:

– Unexpected environmental situations or system malfunctions

– Atmospheric conditions: Windshear and microburst, unexpected strong tailwind, crosswind gusts or any external conditions that may significantly affect aircraft lateral control

– Engine malfunction: Asymmetric thrust, sudden loss of thrust, thrust reverser unlocked and/or unstowed, abnormal slow engine acceleration, takeoff power not set before 80kt, exceeding engine parameter limit

– Indicated airspeed discrepancy at 100kt, or before (if not rising as expected)

– Aircraft system failure(s) that trigger ECAM messages associated with Master Warning/Caution

– Traffic conflict/ATC instruction (i.e. takeoff clearance cancelled), particularly on congested airports

– Undesired presence of aircraft, vehicle and/or pedestrian on the runway (e.g. runway incursion), particularly on congested airports

– Lack of efficient communication between flightcrew(e.g.:untimely power check, improper speed callout, …)

– Open window or door

– Bird strike

– Broken flight crew-seat latch

– Significant aircraft directional control problem
– Unusual noise and/or vibration (e.g.: nose gear vibration, tire burst, engine stall, suspected bomb explosion …)
– Aircraft tendency to pitch up
– Any conditions where there are indications that the aircraft is unsafe or unable to fly.

In the High speed takeoff roll segment the influencing factors are:
– Severity of the malfunction
– Aircraft speed
– Atmospheric conditions
– Runway characteristic and conditions
– Dispatch under MEL and/or CDL that affects acceleration or deceleration capability.

The Captain will decide whether or not to reject a takeoff, depending on the circumstances.

A. Below 100kt

If a system malfunction is detected (e.g. ECAM caution or warning), when the aircraft is below 100 kt, then the Captain should consider rejecting the takeoff.

B. Above 100kt and below V1

As the consequence of an RTO becomes more and more critical as the speed increases, only very severe conditions should lead to a STOP decision, when the aircraft is at high speeds.

In the high speed segment, the crew should develop a "GO" state of mind. However, the flight crew should never delay a STOP decision, if necessary.

Major failures that may lead to the STOP decision include, but are not limited to:

– Engine or APU fire warnings
– Severe damages
– Sudden loss of engine thrust
– Takeoff configuration warning
– Any malfunction where there is doubt that the aircraft will fly safely.

To minimize the risk of inappropriate decision RTO, the ECAM system inhibits non-relevant warnings and cautions during the high speed regime. Therefore, the Captain must immediately consider all ECAM warnings/cautions that trigger during this segment.

In order to help the Captain limit the decision-making time, the Airbus FCOMs lists all of the ECAM warnings and cautions that should result in an RTO decision. This list, however, is only guideline and the decision to STOP or GO remains the Captain's responsibility, and will mainly depend on the aircraft speed at the time that the ECAM warning or caution triggers, or at the time of the encountered problem.

The V1 callout has priority over any other callout. V1 is considered to be the end of the STOP or GO decision-making process. Therefore, at the latest, this decision must be made at V1, so that the Captain can initiate the STOP actions as close to V1 as possible: V1 is indeed a decision/action speed.

C. Above V1

At V1, the Captain's hand comes off the thrust levers/throttles, and the PF can continue the takeoff even if a malfunction or a problem is then detected, because it may not be possible to stop the aircraft on the remaining runway length (*The Captain can consider to reject a takeoff only in the event that the aircraft is not able to ensure a safe flight).*

Above V1 if a failure occurs, the only actions should be gear up selection and audio warning cancellation, until the appropriate flight path is stabilized and the aircraft is at least 400 ft AGL.

The objective is first to stabilize the flight path, and then to initiate the abnormal procedure without excessive delay. A height of 400 ft is recommended, because it is usually equivalent to the time it takes to stabilize the aircraft flight path.

In some emergency conditions (e.g. engine stall, engine fire), as soon as the appropriate flight path is established, the PF may initiate actions before reaching 400 ft AGL.

The following factors affect the performance of the STOP or GO decision-making process:

- Limited decision-making time
- Recognition time of unexpected conditions (i.e. unusual or unique situations)
- Failure to understand the nature of problems which may occur during take-off roll
- Non-adherence to published standard calls (e.g. 80kt/thrust set, 100kt, V1)
- Flight crew coordination
- Complacency
- Inadequate/incomplete pre-flight briefing.

Prevention Strategies

The objective is to clearly specify and train the flight crew about the importance of the RTO decision-making process so that, if such an event unexpectedly occurs, the flight crew's reaction in a real-time situation can be as automatic and as accurate as possible.

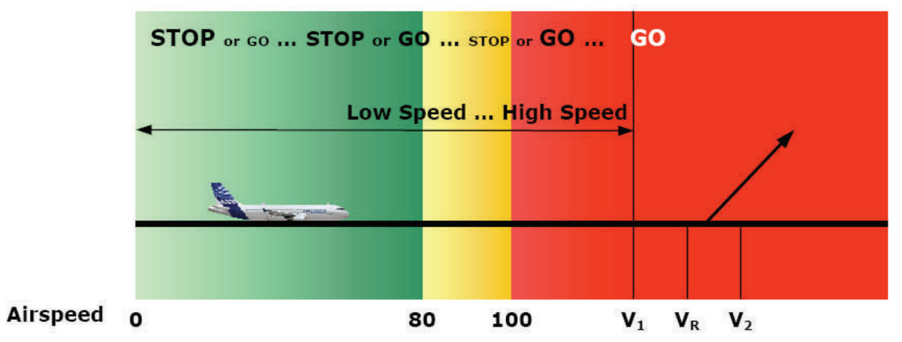
Airline's Policies and Procedures

Operators must define and specify the policies, procedures, and required task sharing for an RTO, in addition to defining its low speed and high speed RTO philosophy. The policy should clearly state which flight crewmember has the authority to make the STOP decision, and who has the authority to stop the aircraft.

Accurate PNF standard calls, at predetermined airspeed "gates", helps the Captain to determine when the aircraft transitions from a low speed to a high speed takeoff roll segment (i.e. 100 knots) and to, therefore, be more and more "GO-minded" (see figure below).

The aim of the "100 knots" callout is:

–To check the coherence of both Captain's airspeed indication and F/O airspeed indication (i.e. both Airspeed Data Computers)



Airspeed Gates to Develop the Proper STOP or GO Mindset

– To indicate that the aircraft is entering the high speed takeoff roll segment.

This further emphasizes the essential support and monitoring role of the PNF during the takeoff roll. The PNF should:

– Perform timely standard callouts
– Monitor thrust parameters
– Monitor speed trend (available on the PFD, depending on the aircraft type) (*An unusual speed trend may be an indication of unreliable airspeed or windshear)*
– Detect and/or identify any abnormal conditions.

The Takeoff Briefing, should include a briefing on abnormal takeoff situations, at least for the first flight of the day, or at each flight crew change. This briefing on abnormal takeoff situations should address:

–The respective responsibilities of the PF and PNF during the takeoff roll (e.g. PNF calls out "power set" below 80 kt, …)

–The Captain's decision whether to stop or go in the case of failure, and the associated call (i.e."STOP" or "GO")

–The respective roles of the Captain and First Officer, in the event of a STOP decision (e.g. the Captain takes control of the aircraft, reduces the thrust to idle and controls the thrust reversers, while the First Officer monitors the deceleration…)

–The respective roles of the PF and the PNF, in the event of a GO decision (e.g. in the case of a failure after V1, the Captain will call out "GO", and the PF will continue the takeoff, with no action other than gear up and silencing audio warning(s), until the aircraft reaches 400ft AGL).

It is recommended that this briefing be adapted to highlight the aspects specific to each takeoff, because such aspects may influence the Captain's STOP or GO decision, and include:

– Takeoff data (high weight, high V1, …)
– MEL item affecting stopping capabilities
– Runway conditions (short or contaminated runways)
– Bird activity, suspected windshear (e.g. microburst)
– Tire conditions and brake wear (exterior inspection)

<u>Training</u>

Flight crew must be trained on the following RTO aspects:

<u>During ground training:</u> The meaning of V1, the reasons for RTOs, the technical understanding of takeoff performance, contaminants, reverse thrust, flap selection and reduced V1, the influence of line-up techniques, and the power setting techniques, …

<u>During simulator training</u>: Maximum braking techniques, RTO on a balanced airfield, tire failures, warnings/cautions that may trigger at high speed, timely V1 callout, …

The joint industry/FAA Takeoff Safety Training Aid provides an example of a takeoff safety training program, including background data about takeoff safety and guidelines to make better STOP or GO decisions. It is complemented by the aircraft manufacturer Takeoff Safety Training Aid. Airbus has a "Rejected Takeoff and the Go/Stop Decision" video. It offers flexibility to incorporate lessons into initial, transition, and recurrent training programs, in order to meet the needs of any Operator.

Performance training should also attempt to improve a flight crewmembers' understanding of the importance of a STOP or GO decision.

Most training programs address RTO decision-making aspects in relation to engine failure at V1 (V1 cut).

It is strongly recommended that recurrent training program, upgrading to Captain course and Line Oriented Flight Training (LOFT) scenarios, also include simulator exercises that require the flight crew to detect and identify abnormal situations that are not the result of a clear and distinct loss of thrust, such as:

- Engine stall accompanied with loud bang (without loss of thrust)
- Tire burst
- Traffic conflicts ("Abort" ATC instruction)
- Engine oil low pressure close to V1.

The following items should be discussed during recurrent training:

* Nose gear vibration, opening of a sliding window, … should not lead to rejecting a takeoff at high speeds (above 100kt)

* Tire burst in the V1 minus 20kt to V1 range: Unless debris from the tires have caused serious engine malfunctions, it is far better to get airborne, reduce the fuel load, or proceed for an overweight landing, and land with a full runway length available

* Bird strike at high speed:

- If the bird strike is only suspected, the takeoff should be continued.
- If the bird strike is confirmed, but engine bird ingestion is only suspected, the Captain must evaluate other factors i.e. How many engines are affected? (The decision may differ for a 2 or a 4 engine aircraft) Statistically, a continued takeoff followed by an In-Flight Turn Back (IFTB) is a preferred option.

The decision to reject a takeoff may be a good one, if:

–Bird strike is confirmed
–Engine bird ingestion is probable, and
–Some thrust effects are detected.

Rejecting a takeoff allows the engines to be inspected.

In any case, the takeoff must be interrupted, if a thrust loss is detected before V1.

* Windshear or uneven aircraft acceleration during the takeoff roll:

Before V1:

– The Captain should reject the takeoff only if unacceptable airspeed variations occur and the Captain assesses there is sufficient runway length to stop the aircraft
– If windshear occurs during the takeoff roll, V1 may be reached later (or sooner) than expected. In this case, the Captain may have to decide if there is sufficient runway length to stop the aircraft, if necessary.

References:

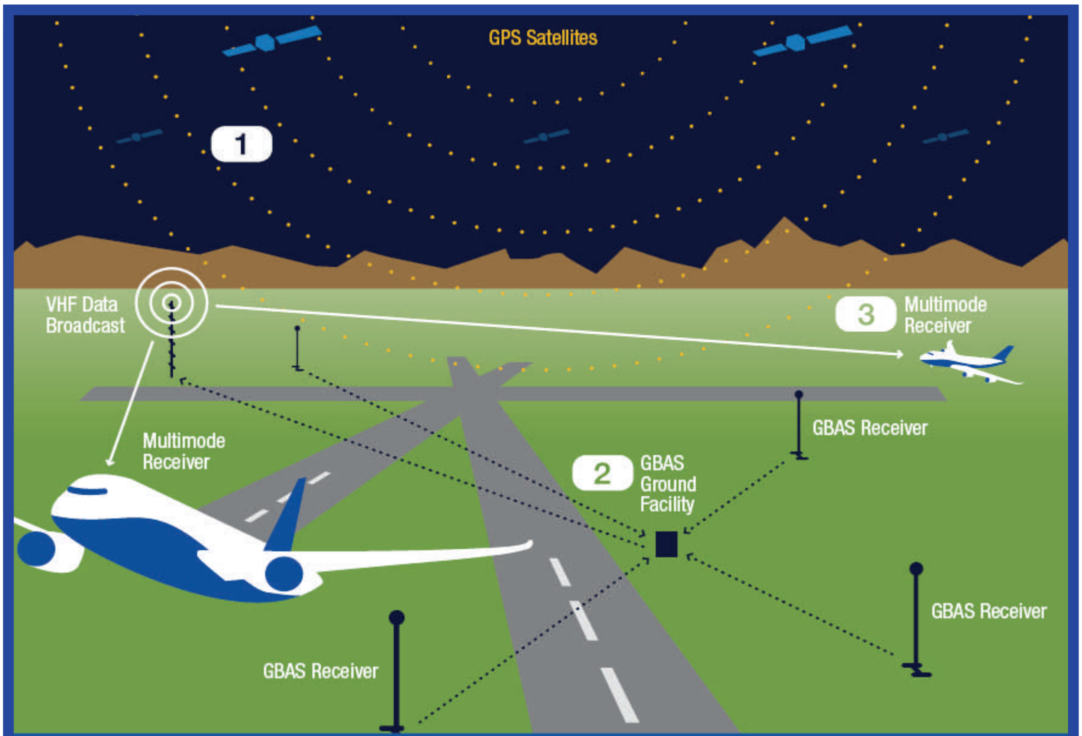
1. "Rejected Take off studies", Boeing Aero magazine, No.11.
2. "Revisiting the "Stop or Go" decision", Flight Operations Briefing notes, Airbus Industrie document 2000, Dec. 2005.
3. Patrick Veillette, ' Don't stop now!" , Business and Commercial Aviation, July 2005.
4. Pilot guide to Takeoff Safety, Section 2, FAA
5. Takeoff Safety Training air, issue 2-11/2001, Airbus.

***KAC Operations Policy Manual,** section 4.9.7 Rejected Takeoff defines V1 and details the actions to be carried out during a RTO. Further, section 4.9.8, details the action for engine failure at or after V1, which is to proceed with takeoff.*

Boeing's Satellite-Based Airport Landing System

adopted from Water Polt's article in August 2008 issue of Boeing Frontiers

Boeing has developed a Global Positioning Landing System (GLS) based on GPS that will replace the aging Instrument Landing System (ILS).



Boeing's new landing system: (1) Signals from in-view Global Positioning System satellites reach multimode receivers (in airplanes) and Ground Based Augmentation System (GBAS) receivers (on the ground). (2) The GBAS ground facility detects any errors in GPS signals and sends corrections (and digital approach information) to airplanes via VHF broadcast. (3) On board the airplane, the GBAS landing system uses the satellite signals and GBAS corrections to establish and track the airplane's true position—and gives the autopilot precision landing instructions. DAVID DANNER GRAPHIC

After a decade-long program with the FAA and RTCA Inc. to develop internationally harmonized standards and address any system safety issues, Boeing and the aviation industry now have a new capability—known by the acronym GLS. This technology, which is one part of Boeing's overall air traffic management strategy, can enhance safety, reduce airplane noise, fuel consumption & emissions, and increase airport arrival and departure capacity, especially in bad weather. GLS is in use with the Next-Generation 737 and is set to be a basic feature on the upcoming 787 Dreamliner and 747-8; it's also an option on the Airbus A380.

ILS is a WWII vintage technology which underwent improvements. ILS system gets affected by nearby objects such as terrain, vehicles and airplanes, and keeping ILS protected from these disturbances is cumbersome. It may be recollected that in the Delta connection landing overrun detailed in the Jan. 2009 issue of flight safety, "ILS system was affected by snow and the glide slope minimums were temporarily raised to localizer only."

ILS is also expensive to purchase and maintain. ILS offers little of the flexibility needed for future air traffic management operations. Global positioning Landing System (GLS), on the other hand, provides pilots variable approach paths and adjustable glide slopes and runway touchdown points. GLS procedures readily integrate with Required Navigation Performance (RNP) instrument procedures in the process of being adopted. Together, these capabilities are some of the tools available for high-capacity, high-efficiency operations.

GLS integrates data from the GPS satellite system, ground stations and a multimode receiver on the airplane to provide pinpoint accuracy of the airplane's position relative to the runway and surrounding terrain.

Boeing's GLS system is digital. It augments GPS signals, making limited-visibility landings precise to within 6ft (~2m), exceeding ILS accuracy. To support such accuracy requires two components. One is a Ground-Based Augmentation System (GBAS): a land-based computer-and-antenna system developed by Honeywell, among others, that rebroadcasts satellite-generated GPS navigation data corrected for local signal conditions. The other is an on-board multimode receiver capable of correctly receiving and processing the signals from the satellites as well as from the GBAS ground station. Together these elements support an airplane-level function and has all the functionality of the previous ILS and much more.

The GBAS essentially tells the incoming airplane its true position and it can also broadcast precision digital approaches that guide the autopilot to a landing.

GLS offers many benefits. A single GBAS station can serve multiple runways—perhaps even at multiple nearby airports, thus eliminating the intricate installation, calibration and maintenance of million-dollar ILS devices at both ends of every runway. GLS is a much more flexible way to get ILS-type approaches without the expense of the ILS installation.

In addition, any airport anywhere can install GBAS. That gives fast-growing aviation sectors such as those in Australia, the Middle East and the Asia-Pacific region the opportunity for more affordable precision-guidance access to runways. In turn, this likely will give flights over expansive areas with few airports the availability of additional, closer alternate airports during flights, in case of contingencies such as medical emergencies. That may allow lighter fuel loads, which can help the environment by reducing fuel burn and emissions, while increasing passenger and freight revenues.

With the new GLS. Airlines' pilot-training expenses are minimal, because

Boeing carefully kept instrument displays and crew procedures essentially the same as those used for ILS operations. As pilots are familiar with ILS procedures, no simulator practice is needed to learn GLS.

Despite these potential benefits, initially the industry wasn't completely sold on this system. There was distrust and the concept was not appreciated. The prevailing opinion internationally was that to achieve adequate performance for low-visibility Category IIIb landings GLS would require new signals in addition to GPS—from systems such as the coming European Galileo satellites.

Boeing countered this opposition by tackling it from both technical and operational fronts.

On the technical front, Boeing worked closely with the FAA in recent years to promote GLS as a mature technology. For several years it has been ready for use in Category I ops. (Landing conditions in which visibility is good at least to 200ft (60m) height with a RVR (runway visual range) of not less than 1,800ft (550m).

Boeing also showed that GLS exceeds Category I functioning using today's GPS only—and doesn't need to wait for the input of possible future systems such as Galileo. The result was a growing international support. ICAO is working on standards to allow a GPS-only, single-frequency system to support Category IIIb approach and landing operations - for conditions more adverse than Category I.

On the operational front, Boeing has teamed worldwide with airline customers, air-navigation service providers, governmental aviation authorities, avionics manufacturers and GBAS manufacturers for opportunities to introduce the technology with early-adopter airlines. Boeing has been getting airlines equipped to fly GLS operations on revenue-generating flights.

These airlines operate with onboard GLS equipment certified in 2005 by the FAA for all versions of the Next-Generation 737; and on the ground are Honeywell GBAS stations provisionally approved by the appropriate authorities. Work is under way through the FAA Local Area Augmentation System Program with Honeywell at Memphis, Tenn., to gain full approval for the ground stations' use in U.S. Category I operations.

Airlines making GLS history so far:

- Qantas Airways began operational trials in Sydney in 2006. According to Capt. Alex Passerini, Qantas technical pilot, Boeing 737, Qantas has 14 737-800s doing 10 to 12 GLS approaches every day; completed 1,000th approach; and has purchased retrofit kits to equip 24 more airplanes.
- TUIfly introduced GLS "for reasons of cost and capabilities" and has been flying GLS in Bremen, Germany, since September 2007.
- Continental Airlines in February 2008 received FAA approval for GLS operations on nine 737s at Guam. This is a first in the U.S. national airspace system. Continental has requested provisions for GLS on all new 737s in anticipation of expanded use at other airports.

A new project team that includes Continental Airlines, the FAA Local Area Augmentation System Program Office, The Port Authority of New York & New Jersey, Honeywell, and Boeing is seeking to implement GLS-GBAS operations at Newark Liberty International Airport.

This effort is intended to build on Continental's success at Guam and the anticipated FAA approval of GBAS use in Category I ops. The technology would help protect or maintain airport capacity at Newark when winds change or weather deteriorates, plus serve as a potential operational environment to implement Category III capability in all its subcategories once it is available.

- In January 2009, Qantas A380, the Nancy-Bird Walton, became the first Airbus aircraft flown by an airline to land using GLS.

According to Capt. Alex Passerini, "Qantas A380s would now use the system for approaches to Sydney. It's pretty straightforward from a flight crew perspective, so there's no great burden on the airline in terms of training differences."

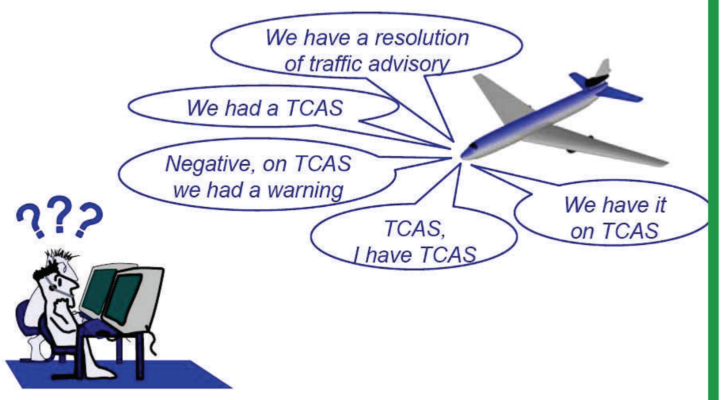
GLS isn't just for commercial use. In a U.S. Department of Defense program called the Joint Precision Approach and Landing System, a variation of GLS is under consideration for both fixed-wing and rotorcraft approaches on ships and land.

PICTURE OF THE MONTH

EXAMPLES OF INCORRECT PHRASEOLOGY

Eurocontrol ACAS II bulletin no.10,Nov.2007 notes that the pilots often report RAs not using ICAO standard phraseology. In some cases, the message is not explicit enough for the controller to determine whether or not a Resolution Advisory has been issued. The figure to the right shows the actually documented examples.

The RA report is crucial as it serves as a notification to ATC that the aircraft is departing from its clearance as a consequence of the RA and the ATC shall not issue any more clearance or instructions. RAs requiring a departure from the current ATC clearance or instructions should be reported as quickly as possible using the Standard ICAO phraseology ("TCAS RA").



The Confidential Aviation Hazard Reporting System (CAHRS) provides a means of reporting hazards and risks in the aviation system before there is loss of life, injury or damage. It is open to anyone who wishes to submit a hazard report or safety deficiencies confidentially and non-punitively. Reports help to identify deficiencies and provide safety enhancement in areas of aviation. CAHRS forms can be collected at different location of KAC (i.e. Flight Dispatch) Premises. Completed forms can be dropped in FS&QA allocated box at Flight Dispatch or e-mailed to kwioeku@kuwaitairways.com or faxed to 00965-4749823 or mail to Flight Safety and Quality Assurance office, Operations Department, P.O. Box 394, Safat 13004, Kuwait Airways –Kuwait.